PARACHUTE JUMPING IN FOREST FIRE CONTROL

REPORT OF FIELD EXPERIMENTS

FALL 1939

REGION 6
U. S. FOREST SERVICE

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ON
PARACHUTE JUMPING EXPERIMENT

AERIAL FIRE CONTROL

U. S. DEPARTMENT OF AGRICULTURE
FOREST SERVICE
REGION 6
FALL - 1939

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Portland, Oregon,
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REPORT ON PARACHUTE JUMPING EXPERIMENT CHELAN NATIONAL FOREST - REGION 6 FALL 1939

By
HAROLD KING AND ALBERT DAVIES

PART 1 - HISTORICAL

INTRODUCTION

During the fall of 1939 the Forest Service, U. S. Department of Agriculture, in Region 6, conducted an experimental parachute jumping project to determine under what conditions firemen or smoke-chasers trained as parachute jumpers could safely land in inaccessible mountainous areas. Field tests of parachutes and protective clothing were also made to determine what equipment was necessary to land safely in timber or other hazardous cover or terrain types, the purpose being to reduce travel time from the discovery of a forest fire to the arrival of the first man, in order that such fires may be extinguished while small. This report deals with the conduct and results of that project.

Parachute jumping is not new. Neither is the proposal for using parachutes as a device for transportation of fire fighters. Region 4 has made such suggestions. Various members of Region 6 have discussed it off and on for several years, with serious attention developing in the summer of 1939. This led to definite proposals for conducting an experimental project, after considerable objective nation-wide investigation through inquiries to the military services and the manufacturers during the summer. News items indicate that Russia and other countries have used parachutes as a device for transporting personnel, which has become common practice in these countries.

INITIAL ACTION

Responding to one of the numerous letters sent to the parachute manufacturers for information, Mr. Beach Gill, of the Eagle Parachute Company, Lancaster, Pennsylvania, arrived in Portland, Oregon, prepared to demonstrate his equipment. This was done.

Project personnel realized that the success of the project would depend upon the safe descent and landing of the jumpers. Therefore, every phase of the jump, from the pre-flight preparations and inspection of equipment to the let-down from a tree landing, was analyzed and planned to remove any probable danger which might cause accidents. Preliminary study of the timber jumping project and the demonstrations revealed the fact that aerial smoke chasers making intentional landings in trees would of necessity have to be equipped with protective clothing and with some type of a maneuverable parachute having a low rate of descent.

APPROVAL AND FINANCE

A definite proposal for conducting an experiment was submitted to the Chief's office, and approval was soon forthcoming. Funds for conducting the work were made available from the all-Service fire experiment fund. It was proposed that the project consist of the following:

1. To determine the feasibility of landing smokechasers from airplanes by parachutes in rough terrain at high altitudes and in timbered areas.

2. To develop and test protective clothing suitable for safe landing in timber, rocky areas, on steep slopes and other hazardous jumping sites.

3. To make preliminary investigation of devices and procedures for applying the method if found practicable, including communication, reaching the ground after being lodged in the trees, retrieving the parachutes, personnel, and equipment.

CONTRACT

A contract was prepared providing for parachutes, protective clothing, and the services of riggers and jumpers. The Eagle Parachute Company of Lancaster, Pennsylvania, was the successful bidder. The supervision of the experiment and the necessary aircraft were furnished by the Forest Service. (See appendix for copy of contract.)

PERSONNEL

The following personnel participated in the smoke-jumping experiment in Winthrop, Washington, October 5 to November 15, 1939:

From the Division of Operation, R-6:

Lage Wernstedt, Project Leader
Harold King, Engineer-Pilot
Albert Davies, Technician

From the Chelan National Forest:

Walter Anderson, Fire Assistant (Project Leader following the illness of Mr. Wernstedt)

From the District Ranger Station, Winthrop:

Frank Burge, Field Adviser

From the Washington Office Fire Control:

David P. Godwin, Assistant Chief of Fire Control (Present during first month of field tests)

Mr. Beach Gill, Collaborator appointed by the Secretary of Agriculture to furnish technical advice.

From the Eagle Parachute Company:

Jumpers and riggers: Frank Derry, Glen Smith

Additional jumpers: Virgil Derry, Chester Derry, Richard Tuttle, Allen Honey

Figure 2

Project personnel of the experiment. Left to right: Beach Gill (Collaborator), Albert Davies (Forest Officer who assisted pilot), Glen Smith (Rigger and Jumper), Chester Derry (Jumper), Harold C. King (Engineer-Pilot), Walter Anderson (Fire Assistant of Chelan National Forest), Dick Tuttle (Jumper), D. P. Godwin (Asst. Chief, Division of Fire Control), and Frank Derry (Head Parachute Rigger and Jumper).

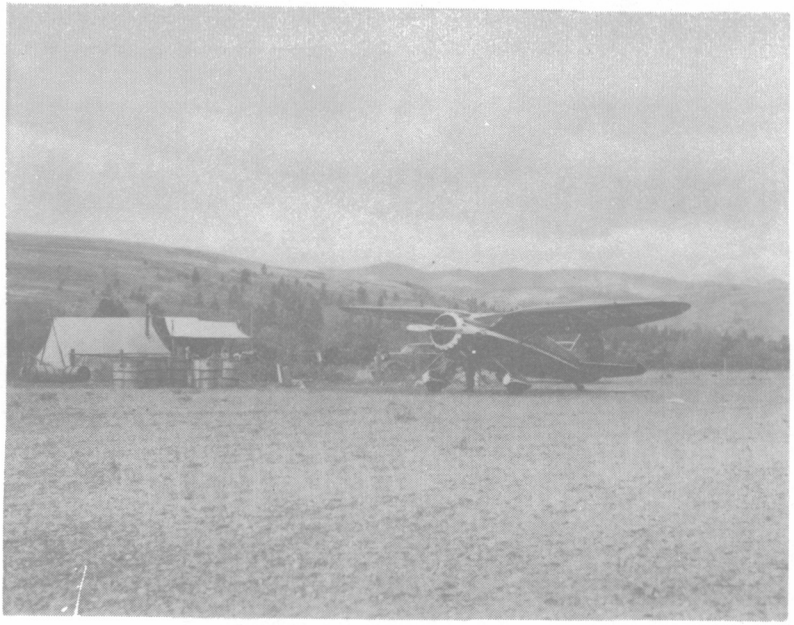


Figure 3

The Forest Service experimental plane at the mooring station, showing the facilities arranged for the experiment.

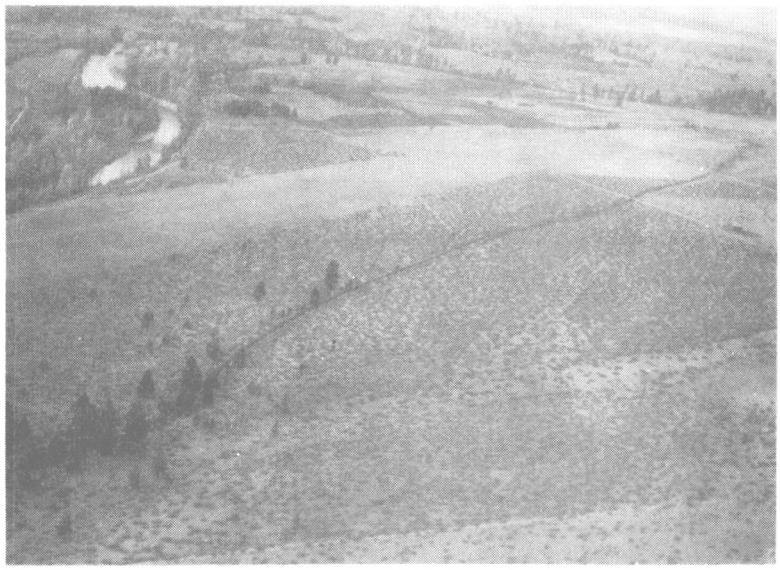


Figure 4

Aerial photo of the Intercity airport a few miles from Winthrop, Washington, used as base for the experimental work.

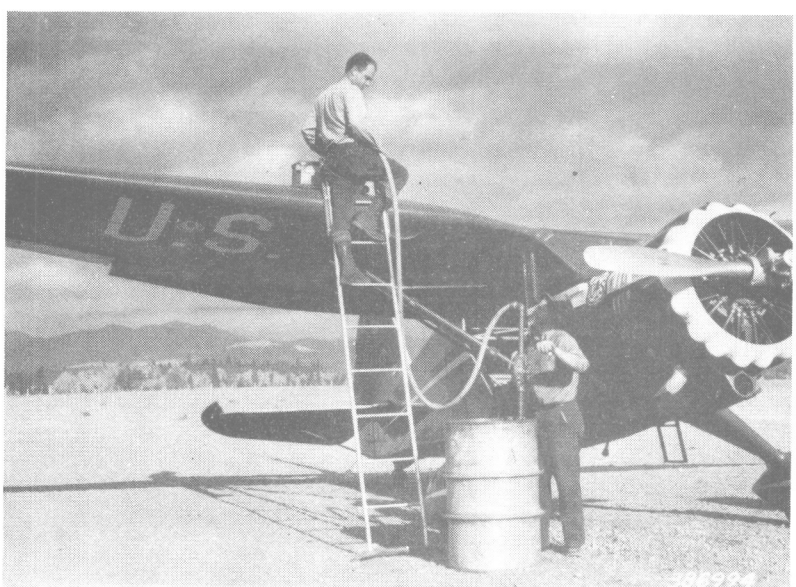


Figure 5

Gassing the Forest Service experimental plane in the field. Note the chamois skin covered funnel resting on the felt pad placed on the fabric of the wing.

PART II - EQUIPMENT

AIRPLANE

The Forest Service experimental airplane NC-2166 was used during this project. This is a conventional commercial 5-place high-wing cabin type of airplane, (Fig. 3) convertible for cargo carrying. It has a full complement of flight instruments and special equipment. The 450-H. P. motor with constant speed propeller gives high performance, making it ideal for use where a quick climb to elevations of 10,000 is desired.

There were no hangar facilities at the airport; therefore, each evening the motor was covered up and the airplane moored. The airplane was operated from a two-way flight field 3000 feet long, with an elevation of 1650 feet. (Fig. 4). (Under the heading of Airport Equipment in the Appendix, materials and equipment needed for the servicing (Fig. 5) and operating of an airplane in the field are listed.)

PARACHUTES

Three different types of parachutes were used on the project: The trial parachute, a R-6 burlap cargo type with a canopy 7' x 7' square; the dummy parachute, the R-1 cargo type, consisting of the surveyed military type parachute with 24' or 28' diameter silk canopy and canvas container; the live jump parachute training outfit, consisting of the main parachute 30' in diameter, of the backpack type with detachable harness, and an emergency attachable chestpack parachute with a 27' diameter canopy.

1. TRIAL PARACHUTE. This parachute is used to determine the summation of the wind drifts so that the pilot may allow for such drift when letting out a jumper, in order that he may land close to the pre-determined and desired location. It consists of the R-6 7-foot x 7-foot burlap cargo parachute, fitted with a 10-lb. bag of sand to provide a rate of descent of 12 feet per second, especially "packed" for quick opening. (see appendix, Rolling the Trial Parachute).

2. DUMMY PARACHUTE. The project personnel, having no precedent to follow with regard to parachute landings in trees and on rugged terrain, decided it would be necessary to make a series of tests with silk parachutes which, on landing, would indicate and point out the problems which would face the live jumper. In addition it was believed that

considerable damage would accrue to the canopies on landing in trees and that this damage would be comparable to that which would occur in a live jump using the training outfit canopies. These dummy parachutes consisted of 24' and 28' condemned and surveyed military silk canopies, shroud lines and risers, weighted respectively with 110 or 150 lb. dummies (sacks of sand) which provided each canopy with a rate of descent of about 12 feet per second.

The canopy, shroud lines, and risers of the dummy parachute are contained within a canvas sack. The open end of the sack is provided with grommets. The bottom or closed end of the sack is provided with a small D-ring. The apex of the canopy is fastened to the bottom of the sack by a string of 20 pound tensile strength. The canopy, shroud lines, and risers are folded in that respective order within the sack and a gathering string of 20 pounds tensile strength is passed through the grommets to close the open end of the sack. The dummy weight (a sack of sand weighing 110 or 150 lbs., depending on whether the size of the canopy is 24' or 28') is next lashed to the ends of the riser snaps and made ready to load on the plane.

In discharging the dummy during flight, the entire assembly consisting of the dummy weight, the container sack loaded with the canopy, shroud lines, etc. are placed in the airplane. Just prior to dropping, one end of a 12-foot static line (3/16" manila line) is fastened to a cabin fitting and the other end of the line is fastened to the aforementioned D-ring at the bottom of the canvas container bag. When the dummy weight container bag has fallen 12 feet from the airplane, the static line will become taut and the weight will string the shroud lines and parachute canopy from the bag, inflate the canopy, and descend to the ground. The flight assistant retrieves the empty parachute bag by means of the static line.

3. LIVE JUMP PARACHUTE TRAINING OUTFITS. The parachute training outfits specified by the contract consisted of a harness with 30-foot backpack canopy, and an emergency attachable parachute (chest pack) 27 feet in diameter. Each parachute was so constructed and rigged that during descent the jumper may turn the parachute to the right or to the left by pulling on the right or left guide line respectively. It follows, therefore, that the jumper may face in any desired direction. Inherent in the design of the canopy

is the ability to "sail" or "plane" in the direction the jumper faces at an air speed of approximately 5 to 8 miles per hour. This speed can be increased slightly, depending on the individual jumper's skill in pulling on the forward shroud lines. The parachute is so constructed that there is little or no oscillation when it is not being maneuvered.

REPAIR EQUIPMENT

A portable canvas table for packing parachutes, as well as the necessary repair materials, were provided by the contractor (see Parachute Equipment and Materials listed in the Appendix.)

TIMBER JUMPER'S EQUIPMENT

For protection against landing in trees, brush cover, or rough surfaces, the timber jumper's clothing consisted of the following: Athletic supporter; back and abdomen brace; helmet with hinged steel wire mask; 10-inch woodsman or forester's boot; outside ankle braces and protective suit. (Fig. 6).

1. Athletic Supporter. Conventional type.

2. Back & Abdominal Brace. A special leather and elastic abdominal belt was designed to guard against possible abdomen rupture or back sprain during the parachute opening. It supports the small of the back and the abdomen. (Fig. 7)

3. Helmet and Mask. A good grade of football helmet was obtained which protects the base of the skull, head, and the sides of the face. The inside of the helmet has a web net, permitting air space between the top of the helmet and the top of the skull. The semi-elliptical wire mask, covering up those parts of the face, jaw, and neck not protected by the helmet, is hinged to the helmet in front of the forehead and fastens by means of a leather strap and buckle at the sides of the helmet. A cup shape padding was fitted at the lower edge of the mask to fit over the point of the chin. (Fig. 8)

4. Shoes. The 8 to 12-inch woodsman's or forester's type of boot, fitted to the individual, is found to be satisfactory for all landings.

5. Ankle Brace. Particular attention was paid to the design of a strong yet quickly removable brace. This is designed to fit over the shoe and lace over the arch, (Fig. 7) to provide ready attachment and detachment. It is constructed from strong cow-hide and provided with eyelets and leather thongs to lace up to the desired tightness.

6. Gloves. Commercial type gloves (known in the northwest as "Swampers") of medium pliable leather which must be snug fitting.

7. Suit. The protective suit contracted for was a one-piece design as ordered. In field tests, however, it was impractical due to the high stiff leather collar, (Fig. 9) and the fact that it was made of one piece limited the action of the jumper's body.

8. Timber Jumper's Two Piece Suit. Special attention was given in the design of the suit to insure ample protection of all joints, including elbows, shoulders, hips and knees. At first it was thought that the commercial air-craft type of foam rubber would be ideal for padding. However, this material gives or compresses too much, and in addition has a tendency to resist any bending. This latter quality tends to stiffen up a suit padded with this material. Likewise it was found in designing the first suit that 12-oz. canvas was too stiff and too heavy for practical use. Therefore, in the design of suit style #2, the materials used were 13-oz. army duck, O. D. shade, padded where needed on the inside with commercial grade of $\frac{1}{4}$" and $\frac{1}{2}$" western felt, style #40.

The military services have for the past few years used a fur-lined two-piece flying suit for open cockpit use during winter flying. This suit of necessity has been designed for warmth and the greatest flexibility and comfort. The Forest Service needs, however, require primarily protection and flexibility and not so much warmth. The military suit was used as the general pattern in design of suit style #2 and style #3.

The smoke jumper's jacket was designed with fullness at the armpits so that the wearer could raise his arms vertically. The collar was made extra large around the neck; and when buttoned, extends up to the back of the helmet and in front up as far as the chin. This collar is made of two pieces of duck stitched together. It is extremely flexible and yet would protect the neck and ward off any branches or foliage it might contact. It does not interfere with the line of vision. The jacket extends down to the top of the hips and in shape and form resembles the outdoor type of windbreaker. (Fig. 10). It is amply padded where needed for protection of the wearer with $\frac{1}{2}$" or $\frac{1}{4}$" western felt Style 40.

The trousers are fitted with suspenders and are worn over the jacket. (Fig. 11). Webbing $1\frac{1}{2}$" wide of thickness of 3/16" extends up the inside of one trouser leg and crosses over to the

other trouser leg at the crotch and continues down the inside seam to the cuff, in such a way as to provide a low crotch, (Fig. 12) where the leg straps of the harness fasten around the thighs. An adjustable strap is fastened to the inside of the cuff and extends around the bottom of the instep to the outside edge of each trouser cuff. The webbing and leg straps, when properly adjusted to the wearer thus form a rigging to which much of the opening shock of the parachute is transmitted when the jumper uses the stiff-legged technique. The low crotch (Fig. 12) also makes it possible for the jumper in a tree landing to straddle a limb and take the shock on the webbing which in turn transmits it to the arches of the boot.

Patches of felt padding $\frac{1}{4}$" or $\frac{1}{2}$" thickness were placed on the inside of the suit to protect all vital parts, including the knees, shins, hips, the abdomen and small of the back.

Both the jacket and trousers are provided with heavy-duty type full length zippers so that they may be donned or removed quickly and with little effort. A pocket 10" x 12" (Fig. 40) is provided to extend from just below the knee to just above the ankle, which is large enough for an 80 foot let-down or climbing rope. The pocket is so tailored that it does not snag during a tree landing. The jacket is provided with a 3" x 6" knife pocket on the top of the right arm sleeve between the elbow and the wrist. The knife is provided with a thong which fastens to the inside of the pocket, which is fitted with a zipper for easy access in case of emergency. (Fig. 13)

The jumper, then, when fitted out with all of the protective clothing, wearing the training outfit consisting of harness, backpack and chest pack, is well protected against any injuries which might occur from a landing in forest terrain at the descent rate used in this experimental project.

Figure 6.

Complete outfit for parachute-jumping firefighter, which includes: suit (one piece type), headgear; braces, gloves, rope, emergency and regular parachutes, standard smoke chaser's outfit and the burlap parachute used to drop the smokechaser's outfit. (Same type used in a trial chute, but rolled differently).

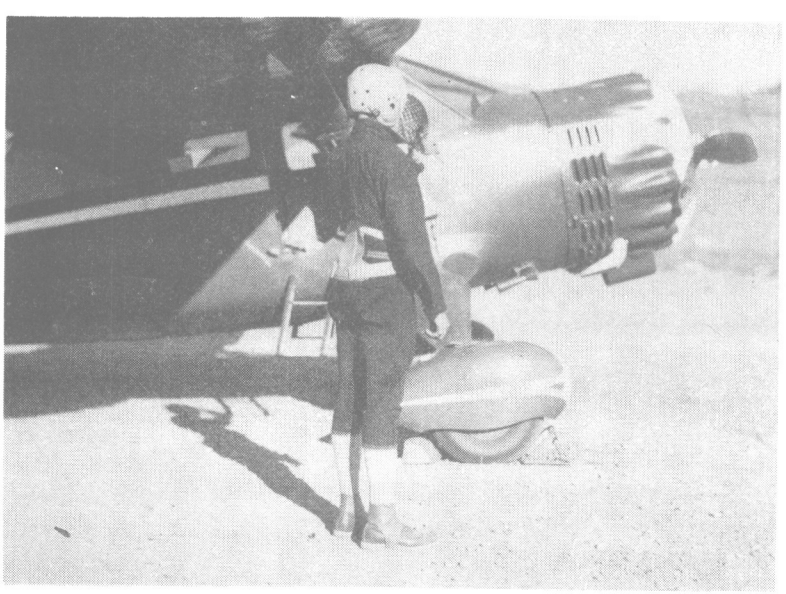


Figure 7.

View showing the timber jumper's ankle brace, back brace and headgear. This shows the face mask being raised for removal and also shows buckle and strap by which the mask is fastened in place.

Figure 8.

This view shows the masked headgear in place and the abdominal support and the leather ankle braces. Note the padding inside the lower part of the mask which cups over the point of the chin.

Figure 9.

The original one piece experimental timber jumper's suit.

Figure 10.

The timber jumper's jacket (unzippered) of the two-piece suit.

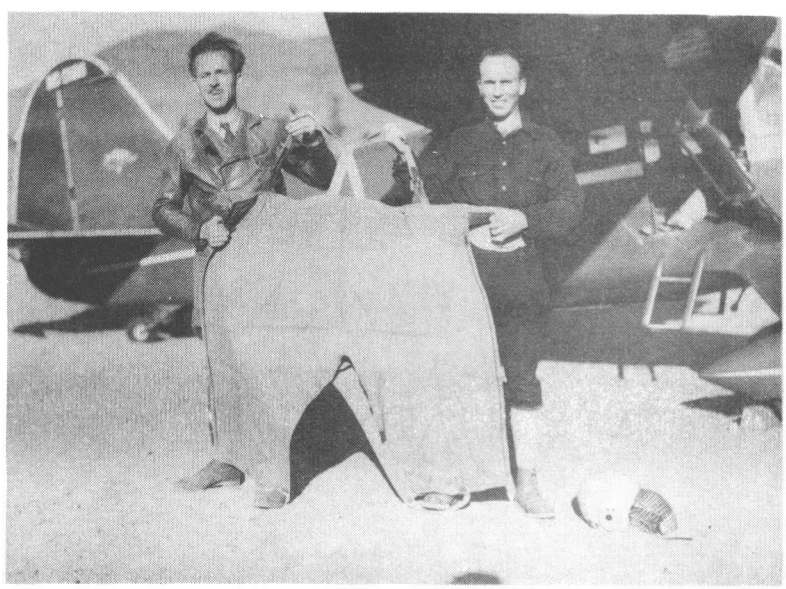


Figure 11.

The trousers of the two-piece timber jumper's suit (unzippered)

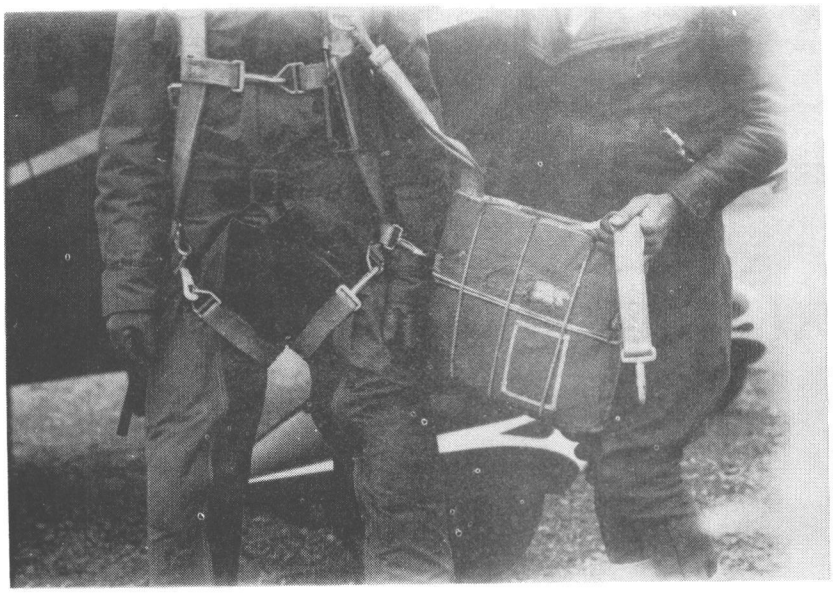


Figure 12.

View showing the webbing across the crotch of the trousers, and forming a low crotch, making a support for the leg straps of the harness. Showing also where the chest emergency pack is fastened to the l ıess at the chest and waist.

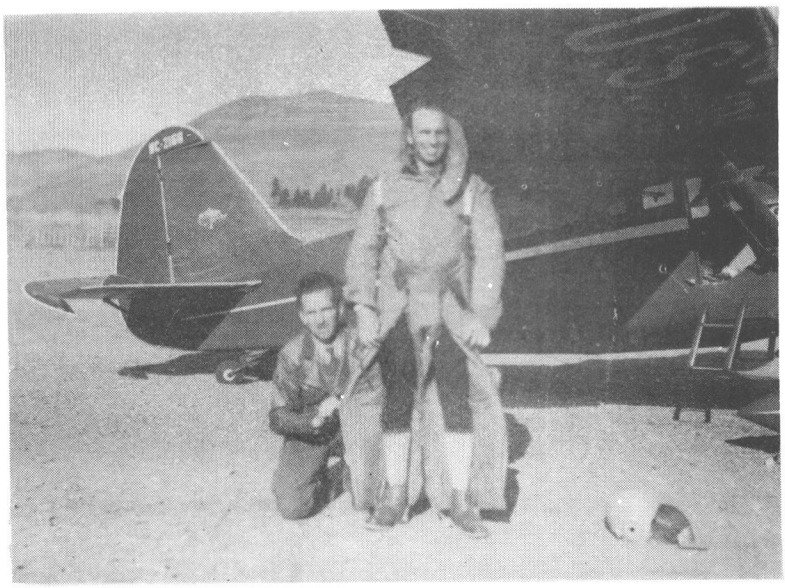


Figure 13.

View showing how the pants of the two piece suit are put on (Zippered from top down to the feet).

RADIO EQUIPMENT

During the conduct of the experiment, the radio net consisted of an airport set, aircraft set, and ground observation crew set.

Smoke Jumper's Radio. The standard Forest Service ultra-high S radio set is not of proper dimensions for use by a smoke jumper. It will need to be redesigned to approximate outside dimensions of 3½" x 4½" x 14" so it can be placed in a pocket attached to the right side of the backpack parachute covering. (Fig. 14). Radio technicians in Region 6 will make ground to airplane tests during early 1940 to determine the feasibility of ultra-high communication which as yet has not been satisfactorily solved. If satisfactory, the smoke jumper will jump with a radio and upon landing immediately notify the plane crew that he has made a safe landing. The radio can also be used to communicate to lookouts with standby ultra-high sets.

FIREMAN'S OUTFIT

This consists of the following one-man smoke chaser's outfit: (Fig. 6 and 15)

Shovel - short handle, detachable.

Pulaski, tool and sheath

Mess kit - 1 man.

First Aid

Headlight with extra battery

Map case with map, compass, etc.

Canteen

Rations - 1 day

Rubber backpack and pump.

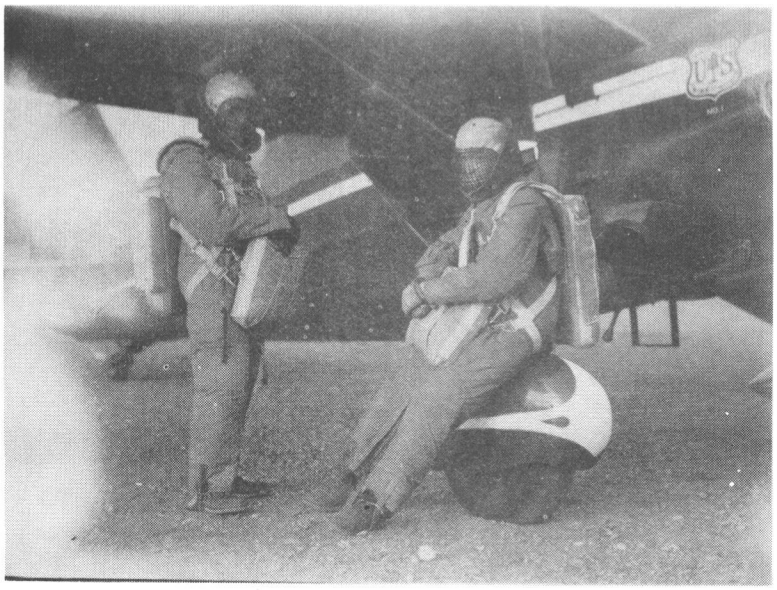


Figure 14.

Two timber jumpers ready to enter the Forest Service experimental plane. Note the pocket for the radio on the backpack of the jumper on the left.

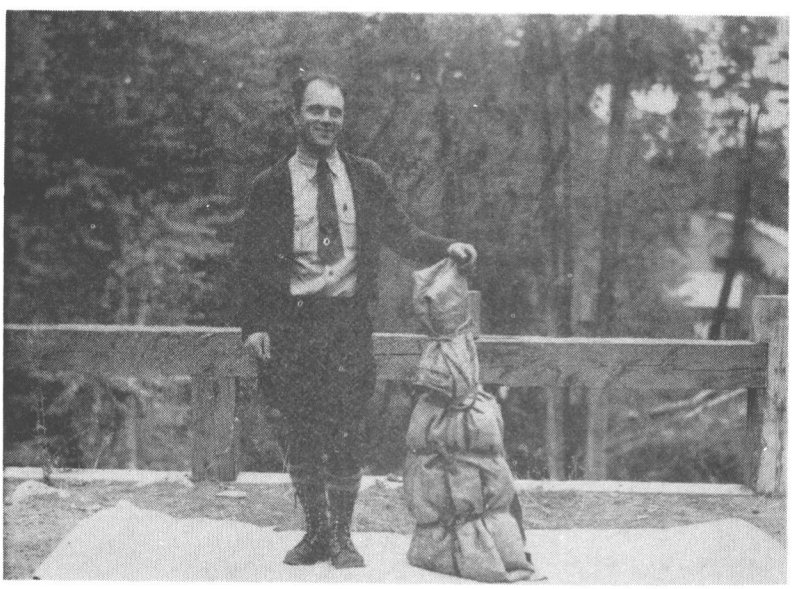


Figure 15.

Fireman's outfit bundled up ready to attach a burlap chute and yellow streamer for dropping to smoke jumper.

Figure 16.

A "first timer" receiving instructions for a preliminary practice "take off" on the ground.

PART III - CONDUCT OF PROJECT

PROJECT BASE

The Winthrop Ranger Station of the Chelan National Forest was an ideal base for the project. The variety of terrain, cover, airport facilities, and proximity to ranger warehouse were the deciding factors in the choice. The Chelan National Forest contains large areas having few trails or roads, making this wooded cover ideal for the development and later application of smoke jumpers' experiment.

It required only a few minutes of flight from the local airport to make jumps over the following areas:

1. Flat field for spot landing practice.
2. Meadows of varying sizes at varying elevations.
3. Open ridges from 4000 to 7000 feet elevation.
4. Brushy ridges, level and on slopes.
5. Ridges with large boulders and down timber.
6. Young growth 20-30 feet high, flat terrain.
7. Young growth 20-30 feet high on slopes 4000 to 6000 elevation.
8. Open mature timber, flat terrain.
9. Open mature timber, slopes.
10. Heavy mature timber.

PREPARATION FOR THE EXPERIMENT

After many conferences, detailed plans were prepared at regional headquarters for the experiment. Lists of equipment for ground and air crews included all items necessary for the servicing of the airplane; ground crew equipment for retrieving parachute jumpers; motion picture and still picture cameras for photographing jumps, and special equipment needed for report preparation. Motor transportation was furnished by the regional warehouse and the district ranger.

Project personnel were divided into three groups: the ground crew, the air crew, and the parachute jumpers, including the riggers, each group having special and particular duties. A recorder was appointed from the aerial fire control personnel to keep a diary record of the experiment.

The project leader in charge of all members of the project worked with the ground crew and selected the various jumping sites, which were near passable roads. The principal duties of the ground crew were to make observations and field notes of parachute descents and landings in the various cover types. The ground crew consisted of the tree climbers, first aid personnel, and others who aided in retrieving equipment and jumpers when lodged in trees. (During the latter part of the experiment a technique was developed whereby the jumper could remove himself when lodged in a tree and let himself down by his own efforts.)

The air crew consisted of the pilot and observer, whose duties primarily were to assist in the pre-flight preparation and inspection of the jumper's equipment, to make observations and to take field notes of the jumper's reactions and techniques during the ground preparation for the jump and until he made the take-off from the aircraft. The air crew also assisted in the development of the technique for jumps while in the air and prior to the actual take-off jump from the airplane. All matters pertaining to the repair service and maintenance of the airplane were handled by the air crew.

The parachute crew (riggers and jumpers) made jumps, instructed first-time jumpers (Figure 16), repaired and altered parachute equipment. Their specific duties also included a written narrative report of their respective jumps, including landings.

EXPERIMENT PROCEDURE

1. Trial Parachute Tests

Prior to dummy parachute and live parachute tests, a burlap R-6 cargo parachute was calibrated using a 10-lb. sack of sand to provide a rate of descent of about 12 feet per second. This rate of descent was equal to that of the dummy parachutes and the 30-foot training parachutes.

During flight it is impossible for a parachute jumper or a pilot to gauge accurately what the summation of the wind drift of any parachute will be for a given territory during its descent. Therefore, a trial parachute is first dropped in order to determine just what the resultant drift of the various winds will be during the descent from the airplane to the ground. For example, if the parachute lands 300 yards short and 200 yards right of the target with respect to the direction of flight, then the pilot knows that on the next approach, a trial parachute or parachute drop should be made at a point 300 yards ahead and 200 yards to the left of the preceding drop, in order to land in close to the target.

Therefore the trial parachute was necessary to ascertain the exact point over which a dummy parachute should be dropped or a jumper should make the take-off jump from the airplane in order to land close to the target. In practice, the trial parachutes performed satisfactorily.

2. Dummy Parachute Tests

Feeling that it was imperative that dummy tests should be made over certain types of cover before any live jumps were made, the project personnel made extensive tests by dropping

Figure 17
Dummy parachute descending above the tree tops.

Figure 18
The edge of the canopy of this dummy chute caught over the top limbs of this ponderosa pine tree.

Figure 19
The canopy enveloped several lodgepoles supporting the dummy weight above the ground.

Figure 20
The dummy weight being supported between a pine and a fir tree by the edge of the parachute canopy hooking over both tree tops.

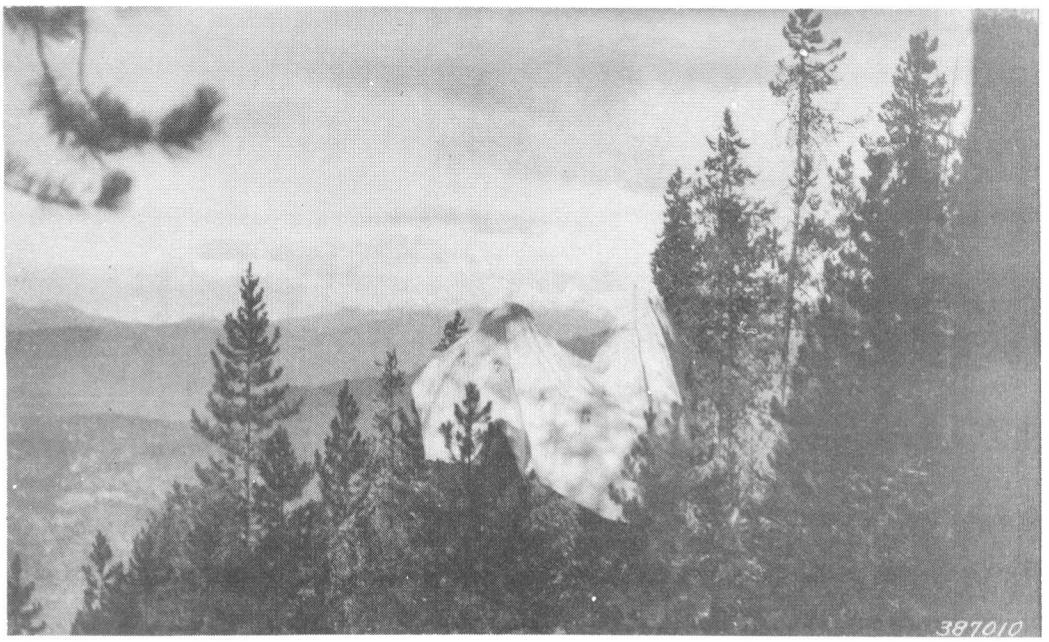


Figure 21
This dummy parachute enveloped several young tree tops on the steep hillside.

dummies. The dummy tests were made with condemned army parachutes converted by Region One into cargo chutes. Most of these parachutes were 24-foot canopies with which 110-lb. sandbag dummies were used. A few of the 28-foot canopies with the 150-lb. dummy were also used.

The object of the dummy tests was to determine the action of the dummy and the parachute while coming into a tree (Figure 17), hooking onto the side of a tree, or slipping off the side of the tree and descending between trees.

Observations of these tests showed that a dummy and canopy on approaching the top of a large crowned tree had a tendency to float over the tree and not hook onto it. Some of the dummy parachutes enveloped the top of the tree (Figure 18) or trees (Figures 19 and 20), some hooked onto the sides of the tree crowns (Figure 21), and others passed down by the limbs, without hooking or collapsing. One drop was especially interesting in that the canopy hooked over a limb, collapsed, broke off the limb, and let the dummy and chute drop free for a few feet. The parachute reopened (inflated), letting the dummy land easily on the ground. In no instance did a dummy test show any indication that there would be danger of a jumper getting hurt on landing in trees.

3. Live Jumps

Live jumps were first made at the airport (Figure 22) to acquaint the jumpers with this large 30-foot diameter new type of parachute and the timber jumper's suit. Each new jumper, forest officers and smokechasers included, made the first jump at the airport, wearing a timber jumper's suit.

The following parachute jump reports, Nos. 29, 52, 54, 55, and 58 have been extracted from the parachute jump tests given in the appendix.

Jump No. 29 is a tree landing made purposely to test the utility of detachable risers and to work out the let-down procedure from the tree to the ground.

Jump No. 52 pertains primarily to the "jump test" with dummy or simulated radio equipment on the right side of the parachute backpack. This jump was made over extremely rugged, hilly terrain of 4000 feet elevation, from a plane altitude of 9000 feet, under adverse wind conditions.

Jump No. 54 was made over same terrain, under same conditions as Jump No. 52. This landing was particularly noteworthy in that it was made on the lee side of a hogback slope where down-drafts existed.

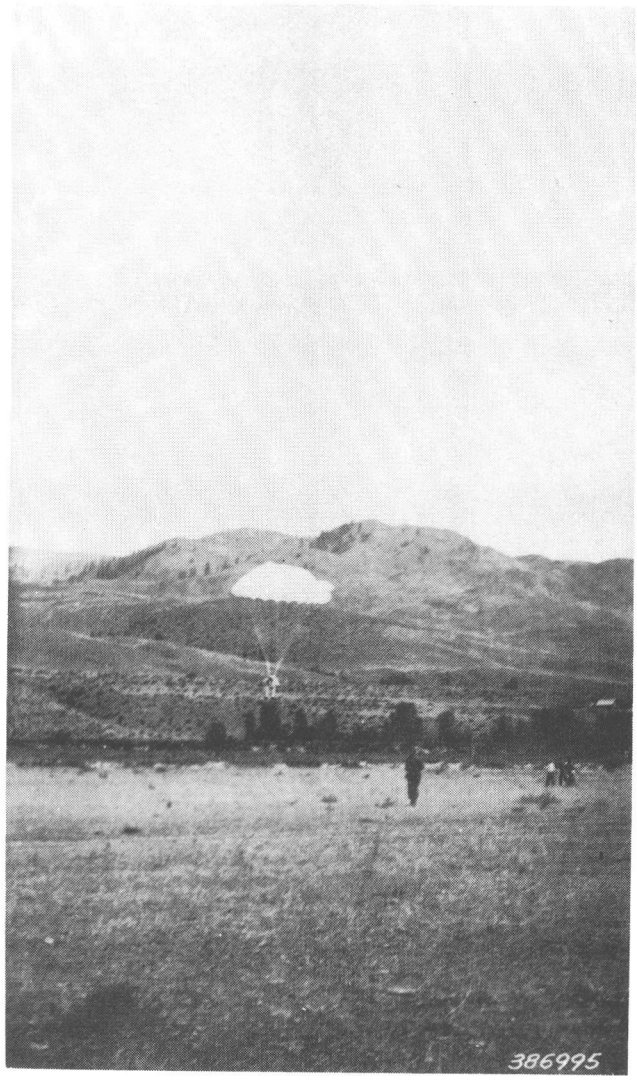


Figure 22
Landing in the center of the airport. Note that no manipulation is being made close to the ground.

Jumps No. 55 and 58 are narratives of first jump "impressions" experienced by Forest Service personnel.

No uncontrollable fear or hysteria was observed during any of the jumps. Out of the 58 jumps, 8 were "first jumps" of forest officers or local smoke chasers whose ages ranged from 22 to 47 years.

Jumper's Report No. 29

Took off 3:20 p.m. for Parachute Flat. Arrived and dropped two burlaps. The first one over-shot and the second under-shot a little. Bailed out as per instructions of Pilot King about one-half way between letting out place of the two burlap chutes. Stepped off step, falling feet first and slightly backwards as intended. Also started falling or turning over on my right side as not intended. Opened chute after falling approximately 2 seconds. Opening shock very easy. After inspecting chute for rips and finding none, noted I was facing away from fire. Turned around to the north, facing fire. Studied position a bit and decided I might over-shoot so turned back south. After descending approximately 300 feet facing south, decided there was very little drift so turned back to the north.

At this time I was probably 1000 ft. from ground and noted ground crew running south from fire or toward me, which indicated they thought that I was going to under-shoot, so pulled down on both front risers to increase drift angle. Held front risers down until about 200 feet from ground and noted forward drift was taking me directly into small clearing. Released front risers and pulled down hard on shroud lines on left side which caused chute to slip sideways into 115 ft. Douglas fir, fouling about 15 feet from the top.

Released right riser first as all of weight was on left riser. Used let-down rope for snatch line to ease pressure on left riser snap which I released. Descended by rope in two stages, bringing emergency chute. Distance of tree from fire, 192 feet.

Ground Crew Observations

This flight was made primarily to test the utility of the detachable riser harness. The risers are fastened to the back parachute packing harness by means of two safety harness snaps. On landing in a tree, the jumper can release one strap at a time rather than to remove the entire harness. This, of course, facilitates climbing down from the tree and also retrieving of the parachute canopy shroud lines and risers.

The jumper steered into a 115-foot Douglas fir. The canopy caught on the side of the tree and in the limbs. The chute and its shroud lines hung like tentacles to a few limbs. The jumper came down unaided using his climbing rope. Several minutes were used posing for news reel photographers.

Jumper's Report No. 52 (Figure 14)

Made jump at Black Pine Lake country. Left ship at approximately 5000 feet above ground. Used Quick Detachable chute with radio pocket containing block of wood simulating radio weight and dimensions. Pilot King slowed ship to approximately 75 miles per hour without flaps, at time of my leaving. Left ship by turning slightly to right to clear radio box of door frame of ship, then turning back to left, facing forward at time of departure, falling feet down (intentionally), toppling over to the right (unintentionally). Dropped about 75 to 90 feet before pulling rip cord, stiffening legs out at same time to absorb opening shock in low-cut crotch of suit. Opening shock not very hard. Looked chute over for possible tears, finding none. Snapped ripcord on snap located on emergency chute for that purpose.

Turned chute around to check on drift and noticed some drift to the north, so held a southerly direction for 300 or 400 feet. Was still getting some north drift so decided to try a hard slip to increase rate of descent. Took hold of about 1/2 of the shroud lines on right front riser and pulled them down hand over hand about 3 ft. Noticed chute started oscillating at first and then started turning around and around quite fast. Pulled down another 18" or so to study action of chute. Chute immediately started making dives toward pulled down portion. Speed of spinning was increased to approximately 1 turn per second. Rate of descent was noticeably increased by rushing of air. Held slip for approximately 1000 feet, released lines, and canopy immediately inflated to full and rate of descent became normal.

Turned chute to face panel located on ridge and noted my position was still south of panel. As the natural drift appeared to be about right to reach objective, no further maneuvering was necessary. At about 100 feet a ground drift was encountered that would apparently carry me over top of the hogback, so pulled down fairly hard on right front riser to create a right drift and a slight right turn. This maneuver was O.K. but should have been executed at a higher altitude. Made very easy landing 60 feet from center of panel.

Ground Crew Observations

Left ship at about the same point as previous jumper. Encountered the same drift but held himself on the windward south

side of slope at all times by expert use of the guide lines, which he kept jockeying back and forth, left and right guide line, to face upwind and reduce drift. He landed 60 feet from the target, just where the crest of the ridge started to slope. In spite of cross-current arising from the mountainous nature of the terrain, the jumper did not oscillate. The landing was easy.

Jumper's Report No. 54 (Figures 35 and 36)

Jumped at 5000 feet above the ground. Open knoll as target. Had every kind of cross wind. It was very hard to turn chute into the wind. Got over the ridge and followed it down. Wind changed quite often. Held position right over target from 200 feet down to 75 feet. I had right-hand risers pulled down to hold position in the wind. At 75 feet up I had sudden gust of wind and turned around to left, going with the wind. Picked up plenty of speed and sailed down over a 50° hillside. Hill was covered with fir trees all about same size. Very close together. The trees were going by so fast I could not tell what kind they were. Dodged one and 75 feet on down the hill before I caught up with another. Chute came down over top of two fir trees. I hit well out on ends of limbs and had very soft landing. Let myself down with my own rope.

Ground Crew Observations

Jumper left the ship at about the same point at No. 53. Struck the same severe cross currents, which he compensated for as required. When over the target at 75 feet altitude, a sudden downdraft caught him. This carried him over the ridge and down the leeward wooded side. His feet hit the top of one 50-foot fir tree just below the ridge. The canopy lodged securely over the top of a 40-foot fir further down the steep leeward slope. The jumper's body came into the branches at approximately 50° angle upward side of tree. Jumper swung himself into trunk of tree, released harness and using a letdown rope lowered himself over a limb to the ground.

Jumper reported an easy tree landing, stating that the branches cushioned him well. He also remarked that a number of limbs had hit against the face mask on his landing.

Time for let-down after being lodged in the tree: 5 minutes.

Jumper's Report No. 55 (Roy Mitchell, Chelan Asst. Supervisor)

At 9:50 a.m. Frank Derry prepared me for taking a parachute jump. Thorough search was made of clothing to be sure no matches were on my person. Stomach girdle or belt at first

appeared too tight for comfortable breathing. Later when chute harness was put on, the strap across chest was much tighter, and I sure thought breathing was difficult. I soon became accustomed to this. Frank Derry then gave me a lesson in getting out of the plane and pulling ripcord (Figure 16). Four-step method of training used. My most nervous time was when suit was completely adjusted. Plane took off and climbed to 5300 feet. Burlap trial chute was dropped and slight southwest wind was noted.

When time came to get ready for leaving plane, Frank Derry gave assuring "Already" and I put left hand on back of pilot's seat, right hand on "side strap" in cabin of ship, thence my feet out door, thence left hand on handle inside of cabin at left of door, thence pulled myself up and with left hand grasped bar outside on plane strut. At same time placed feet on lower step, right hand at this time still on holder strap inside plane; thence right hand on rip cord handle. Frank Derry gave light tap on back with assuring "Go." I did not feel nervous at this time and had full confidence in jump.

I tried to jump straight out and leave step with feet at same time left hand released bar on strut of plane. I definitely counted "one, two" and pulled cord on "three." I believe these counts could not have been over 3/4 of a second per count. I could feel pilot chute feeding out and knew about when to expect jar and opening. When opening came I could feel body being whirled around but did not get any shock that was noticeable, or, in other words, uncomfortable. The descent was excellent. When chute first opened I had no trouble in orienting myself. Located field at once. I found chute difficult to turn to the "right" but could be turned "left" easily. Landing made about 300 feet from target. Landing on ground was very easy. In fact, I could have remained standing if little more freedom at knees in suit was possible.

Ground Crew Observations

Jumper, after receiving forty minutes of instructions in parachute jumping from the rigger, jumped, descended, and landed without event at the airport.

Jumper's Report No. 58

After a parachute had been packed, I went to the airport about 3:30. Plenty of willing hands started in on me. First they stripped my pockets, then I laced on the ankle braces; they then put the "corset" (back brace) on me, then the red coat and pants. Everything was strapped and tied up. The tight back brace was squeezing my light lunch up somewhere in the neighborhood of my throat. But this feeling was soon nullified when they put

the parachute harness on. The main harness straps pulled down on the points of my shoulders so that it felt like the muscle tendons were being pulled slowly out of my neck.

After being hooked all up, Frank Derry wanted me to make a couple of trial exits from the plane while on the ground. Neither exit turned out very gracefully, and Mr. King kept remarking that he wanted me to be sure and let loose of the strut handle when I jumped. In fact, he and Frank reminded me of it several times on the way up. Bus Derry and I chatted while the burlap trial chute was falling.

Frank then signalled me to get ready, so I slid off the seat, pulling on the side strap, then got hold of the ring under the arm rest with my left hand and pulled myself into the doorway. I noticed that my feet were quite a bit above the lower step, but I reached for the strut handle with my left hand and got hold of the ripcord with the right hand. By this time Frank gave the word to "go any time now." I pulled myself out, got my feet on the bottom step and pulled off.

I saw the plane wheel go up by me and felt the wind increasing on my face, could see a blurred image of the ground, so I decided to ease the ripcord handle out of the pocket, but in doing so I must have raised my elbow up so that it caught in the wind enough to pull the pins out because I could see the ripcord coming out of the housing sort of snake fashion. I thought and said, "Oh my gosh, I pulled it too soon." And about that time I felt a pull on my shoulders, heard the "chuck" of the chute opening, and felt my body swing back and forth slightly and then there was an awful quiet. I noticed that the ripcord was still in my hand, so I hooked it onto the snap on the emergency pack.

I had planned on making a good drop clear of the plane when I jumped, but in concentrating on releasing (or not hanging onto) the strut handle I forgot to make any count, but when the ripcord came out the way it did I thought that I was within 10 or 15 feet below the plane and that bothered me because I had thought and intended to fall plenty before pulling the ripcord.

There was no sensation of falling, only the wind on my face due to the fact that I was falling face downward.

After I had hooked the ripcord on, I looked at the canopy and then at the ground. I noticed that I was facing and drifting over the river, so I pulled on the right guide line, which made the chute turn to the right, giving me a slight swinging sensation.

I had the chute headed for the north side of the field, so I began experimenting, pulling on the right guide line and the different risers.

One thing that was very noticeable was the rushing sound of the air through the guide ears of the parachute. Other things were the ease with which the risers and guide lines could be pulled down. Also the lack of noise from the plane as it flew by.

After playing with the chute for a while, I noticed I was over the northeast corner of the field so I decided it was time to turn back toward the target. I pulled on the right guide line hard and harder, but the chute would not turn to the right. (This was due to the wind.) With the right guide line still hooked around my finger I pulled down on the left risers to get hold of the left guide line, but due to the stiffness of the harness and the guide line in my hand the riser slipped out of my hand and I missed the left guide line. So I pulled down on the left back riser and started backwards at an angle towards the target.

I was so interested in the manipulation of the chute that I almost forgot to look at the ground, and when I did I was only about 25 feet above the ground. I let loose of the left rear riser and pulled up my feet and grabbed for all the risers, and I landed lightly on my feet and was pulled backward by the rearward motion of the chute due to the above manipulation. A surprisingly easy landing.

Ground Crew Observations

Jumper, after receiving instructions in parachute jumping from rigger, jumped, descended, and landed without event at the airport.

The next jumps were made on and around a high altitude mountain meadow (Figure 23), with landings in the meadow and in the surrounding sub-alpine timber. The object of these high altitude (6800') landings was to determine whether the ground impact would be more severe than at sea level.

The opinion of the professional jumpers was that there was no noticeable difference in the landing impact at this high altitude from sea level landings. After landing in the trees around the meadow, the jumpers stated they would prefer landing in a tree because their landing was so gentle.

The next area to be jumped in consisted of mature lodgepole (Figure 24) and lodgepole thickets (Figure 25) with occasional tall Douglas fir and dead trees scattered about (Figure 26).

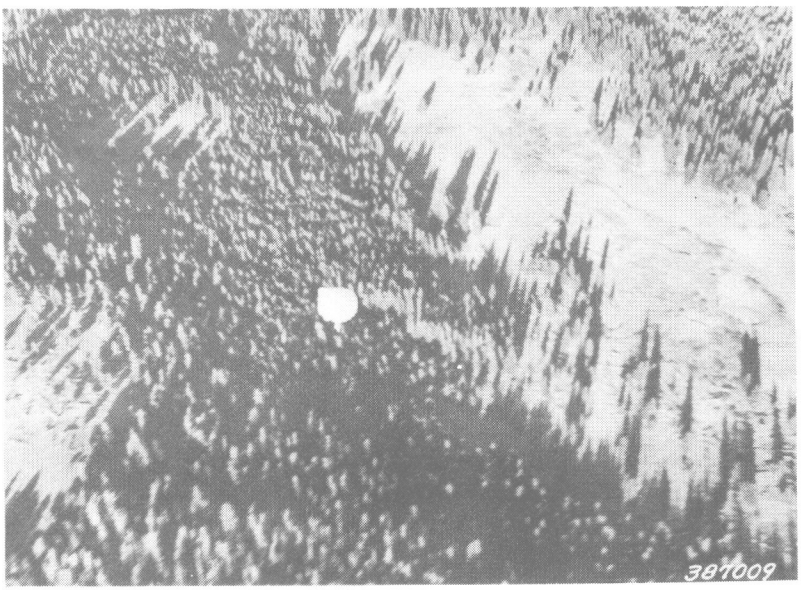


Figure 23

Timber jumper descending over mountain meadow (6800 feet elevation). The jumper is gliding toward the meadow.

Figure 24

This jumper landed in this tall lodgepole tree. He has disengaged himself from the harness and is ready to slide down the tree trunk.

Figure 25
A timber jumper descending over a lodgepole thicket.

Figure 26
The canopy has enveloped a group of young lodgepole trees. The jumper landed safely on the ground among the logs.

The lodgepole landings were characterized by the canopy enveloping from one to fifteen tree tops and the jumpers called them "featherbed landings." (Figure 27)

On one of these landings a jumper grabbed a tree top as he went by, the canopy almost collapsed and the tree top broke off, dropping the jumper free for a few feet, but the canopy opened again and the jumper landed astraddle another short tree which let him down to the ground gently. One landing was made in a 115-foot dead lodgepole which was leaning (Figure 28). Special precautions were taken and jumper descended without a scratch.

Several landings were made in tall firs, and attempts were made for the jumper to do his own extricating. Due to the tightness of the harness and the bulky timber jumper's suit, it was difficult and at first impossible for the jumper to release himself from the parachute harness while being held suspended. A detachable riser with snaps and D-rings was developed by which the jumper could release the harness from the parachute canopy, while being suspended so that he could descend wearing the harness.

The next jump, made to purposely land in a tall tree, was done with a parachute with the above detachable risers. The release and descent were made successfully by the jumper, so several harnesses were fixed with detachable risers.

At this time one of the Forest Service two-piece redesigned suits was received. This type of suit was quite an improvement over the original contracted suit and more practical for smoke jumpers (Figure 13).

Several jumps were made in tall timber consisting of Douglas fir, ponderosa pine, and western larch. One particularly interesting jump occurred when one of the jumpers mistook a frozen, bare, moss-covered western larch for a ponderosa pine. The canopy edge hooked over the top of the tree, the canopy collapsed, the top broke off (Figure 30), the jumper and parachute started a 75-foot drop, but the canopy reopened and the jumper was landed gently on the ground.

The next type of landing was made on hillsides with slopes of 30 to 45 degrees. The open hillside was covered with scattered rocks and stunted brush, and the other hillsides had scattered trees and brush (Figure 31). Landings were made in trees, brush, and on the bare slope without incident. The tree landings were no different from those made on level terrain (Figure 32). It was agreed that landings on hillsides should be made with the jumper facing the slope.

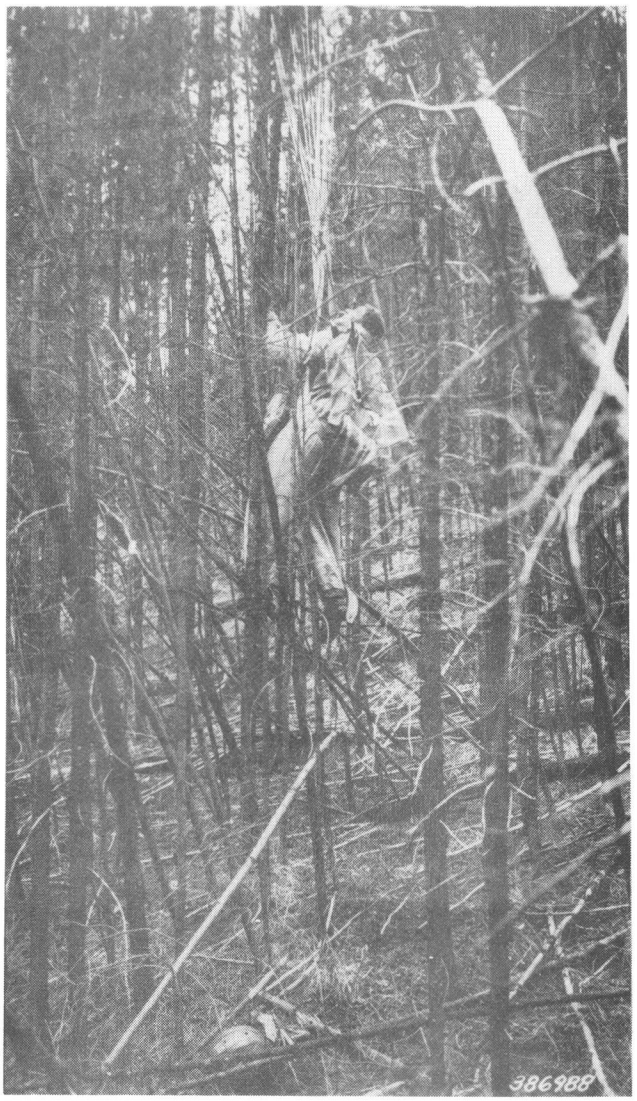


Figure 27

A timber jumper preparing to release himself from the harness, having landed in a lodgepole thicket, termed as a "feather bed" landing. The jumper is suspended above the ground, held by the canopy spread over a large number of lodgepole tops.

Figure 28

This jumper was watching the other snags and did not see the one in which he landed. This was a leaning dead lodgepole.

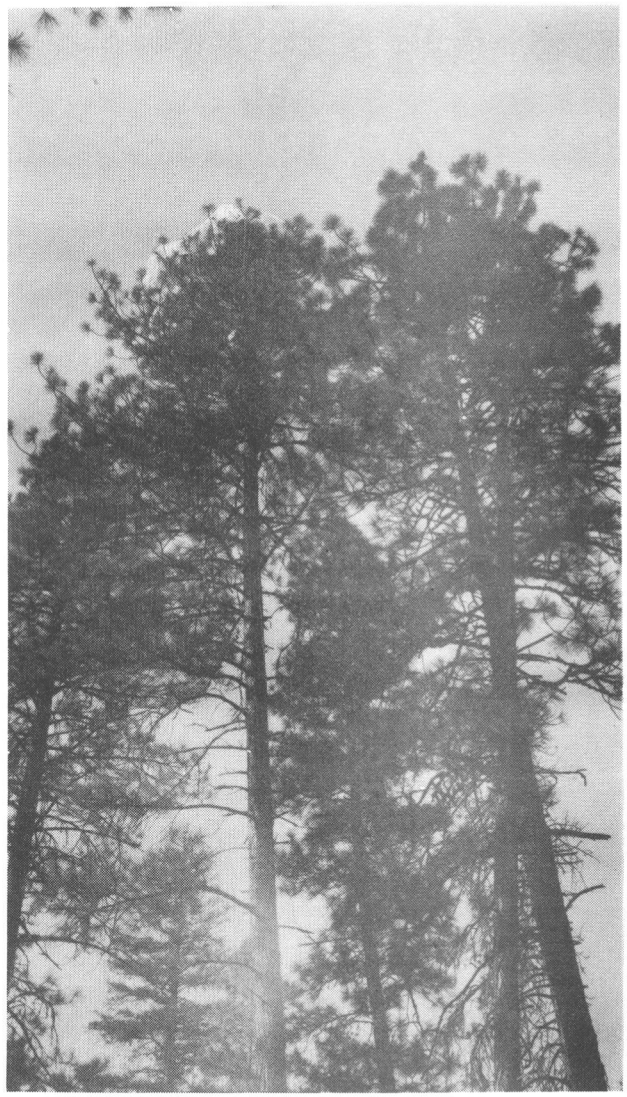


Figure 29

This jumper purposely landed in the tall tree, released his harness from the canopy by the detachable risers, and descended to the ground by the let-down rope shown hanging down along side of the tree trunk.

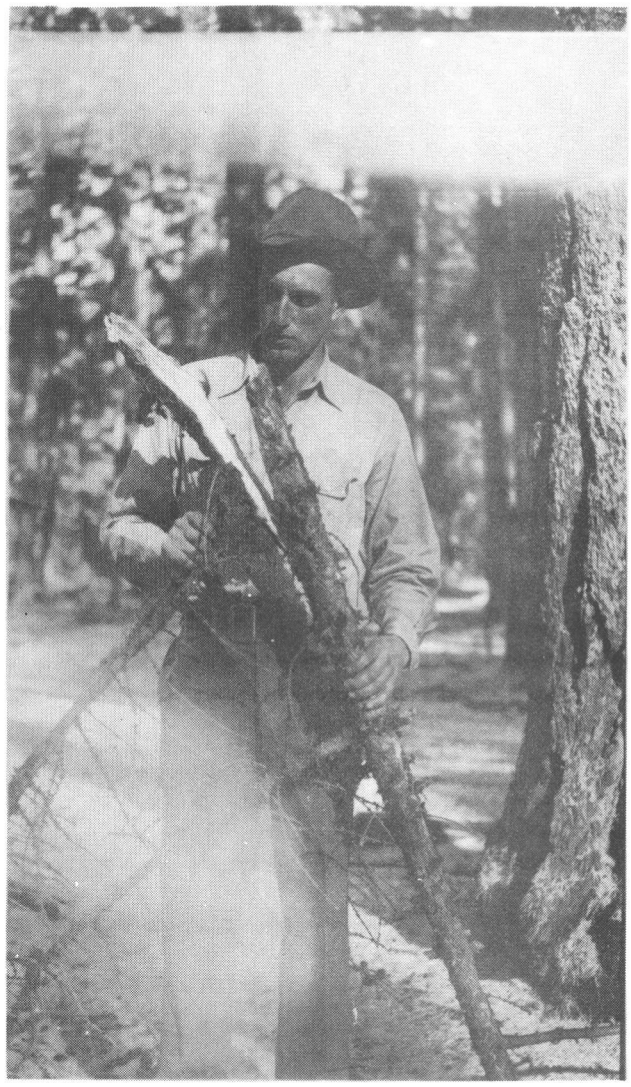


Figure 30

The top of a 115-foot Western Larch which was broken off by the jumper's weight on the parachute canopy, which hooked over the top. The jumper landed gently on the ground, the parachute having reopened.

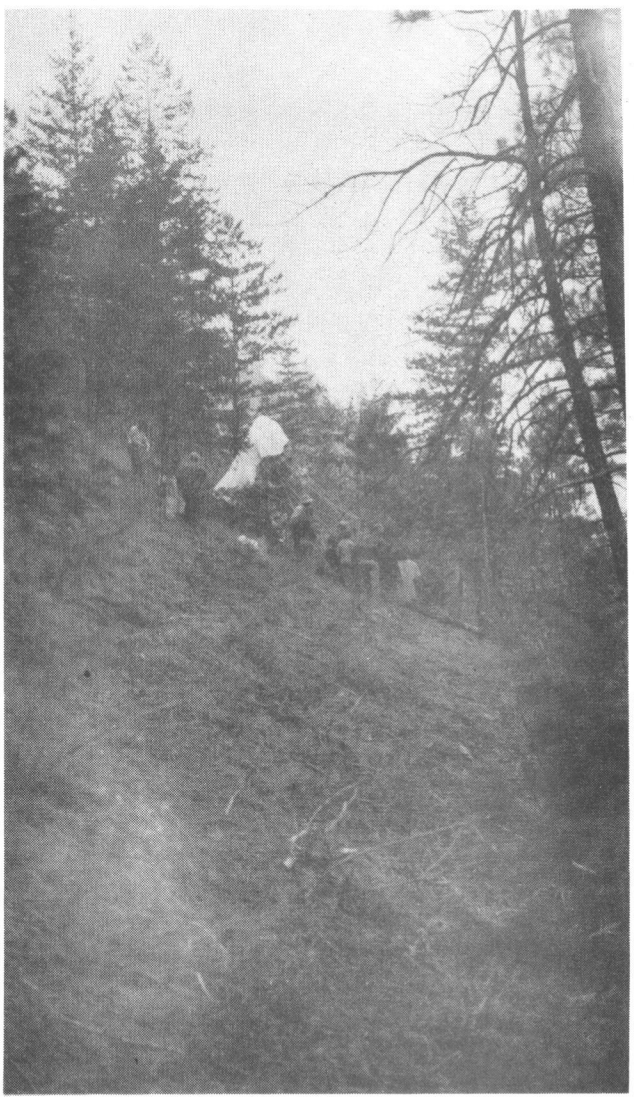


Figure 31
The timber jumper landed on the ground of this steep hillside.

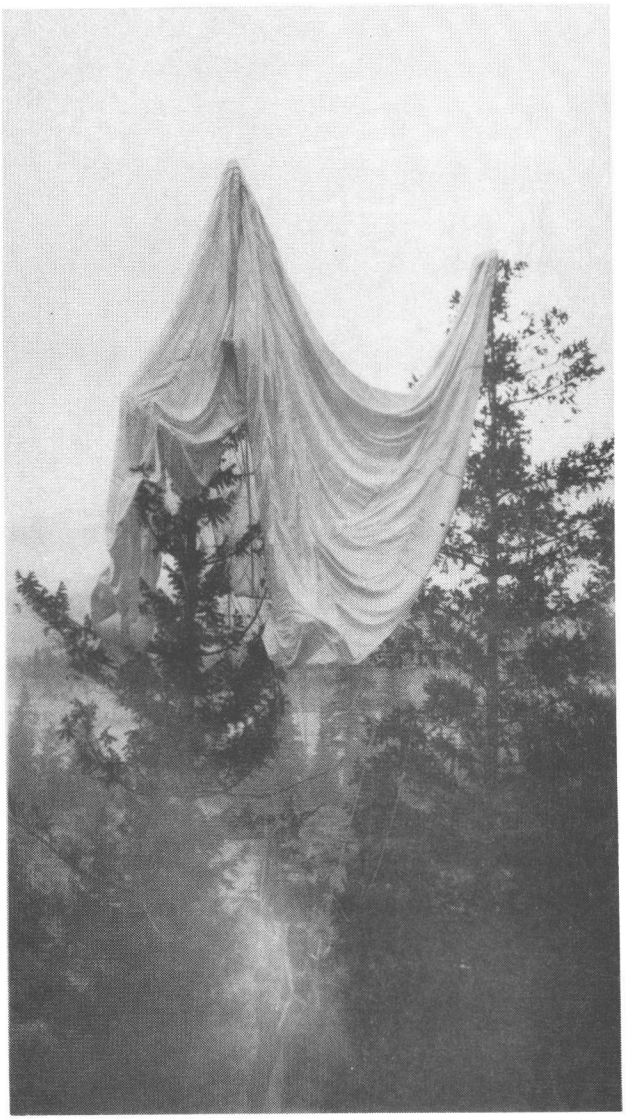


Figure 32

This timber jumper is held suspended between two trees on a steep hillside near the base.

The last type of terrain jumped in was a typical mountain ridge with one bare slope, a narrow top and a timbered slope. Typical cross and vertical winds were encountered by the jumpers in descending to this ridge, causing them to be carried one direction, then another and another, making the jumper work to keep the parachute headed for the target on the ridgetop. Landing accuracy (Figures 33, 34) was attempted by all four jumpers one day. Three landed within 70 feet of the target, but the fourth encountered a sudden gust of cross wind just above the tree tops (Figures 35, 36).

One jump was made by a jumper who had a simulated radio (Figure 14) attached to the right side of his parachute back pack to determine whether exit from the plane could be made easily with the additional width attached to the back pack. The jumper twisted his body in getting out, but nothing caught or even touched the side of the door. He made a good drop away from the plane, being in perfect position for the chute opening. This extra pocket containing a wood block $3\frac{1}{2}$ x $4\frac{1}{4}$ x 14" on the right side of the parachute pack cover did not have any effect on the opening of the parachute or affect in any way the jumper's descent (Figure 14).

TECHNIQUES USED

1. Getting the Jumper Ready

The following procedure was used during the pre-flight preparation of the jumper.

(1) The jumper wears an athletic supporter.

(2) The ankle braces are laced on the outside of the forester's type boot (Figure 7).

(3) The back brace or abdominal brace is then buckled on around the waist (Figures 7 and 8).

(4) Next the jacket (after the one-piece suits were discontinued) is donned. (Figure 10).

(5) The trousers are next adjusted to the wearer and closed by zipping from waist to the trouser cuff (Figure 13). The stirrup straps are passed underneath the instep and buckle to the outside trouser seam (Figure 38). These straps are adjusted to each leg so that the parachute harness leg straps fastening around the thighs will transmit the shock along the inside webbing of the trousers to the bottom of the foot (Figure 12).

(6) The backpack and harness are then snapped snugly on the jumper.

Figure 33
A "bullseye"! The jumper landed two feet from the center of the target cross on a typical mountain ridge with its crosswinds and up and down drafts.

Figure 34
A jumper coming in to land within 70 feet of the center of the target shown in figure 33.

Figure 35

This jumper was not so lucky. A sudden gust of cross wind carried him along brushing the tree tops of the steep timbered north slope of the ridge to land about 250 feet from the target (Figure 36).

Figure 36

This is where the jumper in figure 35 finally landed. In a 40-foot second growth Douglas fir on the steep slope of the ridge.

(7) The chest pack (emergency) is snapped on the main harness (Figure 12).

(8) The shock cord snubber at the base or bottom of the backpack is then fastened to the seat strap (Figure 38).

(9) Inspection.

Inspection consists of visually checking and testing, if necessary, all the main parts of the jumping equipment.

(a) The ripcord pins of each pack are thoroughly inspected (Figure 37).

(b) The ripcord assembly, including its fit into the pocket, is inspected. Particular emphasis is placed on this test. The ripcord housing (Figure 37) is jerked or stretched while the ripcord pin flap is open, to determine whether or not any undue movement on jumper's part can pull the pins from their locking cone and accidentally release the parachute from its cover.

(c) Entire check of the harness, including inspection of the main and auxiliary detachable fittings (harness, snap and D-ring). Particular attention should be paid to the fit of the leg straps around thighs and the tightness of the chest snap and D-ring. The harness should fit tightly and yet allow reasonable comfort for the wearer. A snug harness is a necessity for an intentional jump.

(d) The shock cord snubber of the main parachute, which is located at the bottom of the backpack, is inspected for fastness (Figure 38).

(10) The head gear, including the helmet and its hinged mask, is next fitted to the individual wearer.

(11) The jumper than climbs in the plane ready for takeoff (Figure 38).

Because of a shortage of jumpers' suits and parachute training outfits, sometimes only one parachute jumper was taken aloft. When the equipment was available and retrieved from the field, two jumpers were usually taken on a flight. They, of course, jumped individually on different approaches.

2. Air Technique in Letting Out Jumpers

On approach over the dropping area, a burlap trial parachute was made ready to drop. The pilot picked out a prominent

Figure 37

A close-up of two parachutes worn by the timber jumpers, showing the ripcord pin flap thrown back for inspection of the ripcord pins and housing. The wearer is grasping the ripcord handle in his right hand.

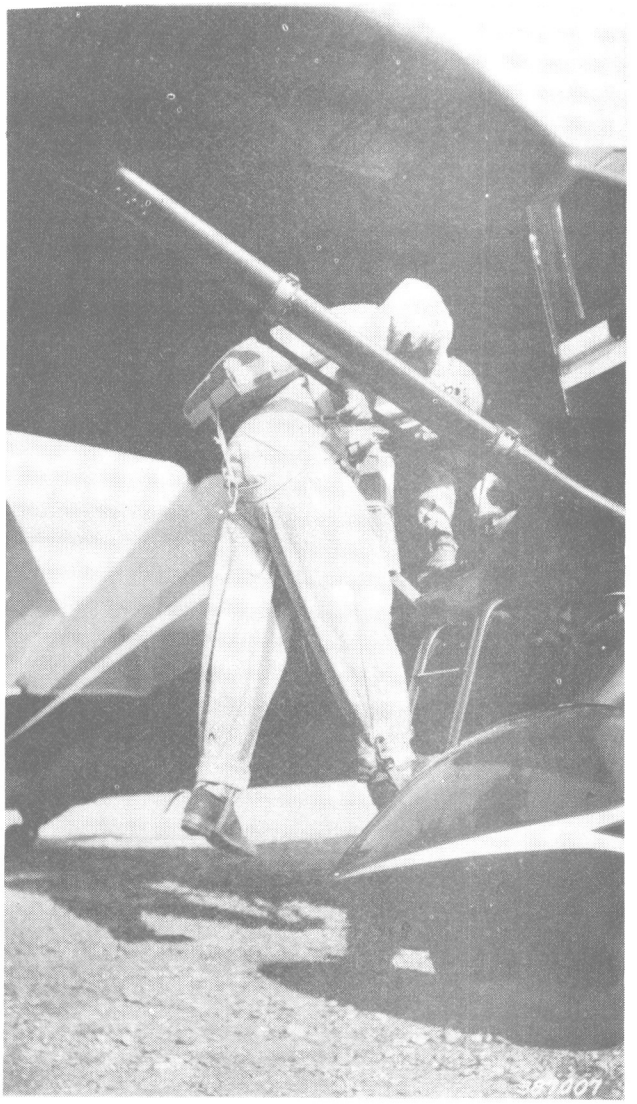


Figure 38

The second timber jumper entering the plane ready for take-off. A good view of the shock cord snubber is shown. Note the freight door is open for the convenience of the jumpers to enter the plane and the main door has been removed for jumping.

landmark over which to drop the trial parachute, after estimating the probable effect from the target fire smoke and the airplane drift.

At the signal "Drop" (verbal or slap) from the pilot, the observer throws the trial parachute outward and downward to clear the plane.

Next, the pilot and jumpers observe the direction and velocity of the trial parachute as it descends to the ground. Sometimes successive parachutes would not have the same direction of drift, due to shift of air currents. However, no jumper was allowed to make his take-off jump until the pilot was satisfied that he would land within 200 yards of the smoke target.

Having ascertained, by means of the trial parachute, the point over which a jumper should exit, the pilot makes a final approach for the jump. Approximately ten seconds prior to the time the jump should take place, the pilot warns the jumper to "prepare to jump."

3. Jumper's Approach to Exit

This procedure was as follows:

(1) First, the jumper, pulling on the support strap next to the door of the plane (like strap on door post of closed sedan) with his right hand, slid off the cabin seat, pushing his feet out the door opening ahead of him.

(2) The jumper, assisted by the member of the plane crew holding one of the back cross straps of the parachute harness as a safety measure while the jumper was moving around in the doorway, would take hold of the arm rest brace on the left side of the door with his left hand and pull himself into a sitting position in the doorway.

(3) The jumper would then place his feet firmly on the lower step.

(4) The jumper would then reach out the door with his left hand and get hold of the pull-out bar which had been placed on the rear edge of the wing strut. (He was still being held or steadied by the member of the air crew.)

(5) He would then let go of the support strap with his right hand and firmly grasp the ripcord handle (Figure 16). At this point the jumper is ready for the signal from the pilot. (Some of the jumpers liked to stick their head out and take a look at the ground, etc.)

4. Jumper's "Take-off" from Airplane

There usually was only a second or two wait for the jumper in the above position and when the pilot was over the desired point he would give the signal "Go." The assistant would let go of the back strap, slap the jumper on the shoulder, and shout, "Go."

On take-off the jumper would proceed as follows:

(1) The jumper would reach farther out on the pull-out bar;

(2) Pull himself out of the door;

(3) Drop off the step, twisting his body to face forward (same as direction of airplane) with the body tipped slightly back and the feet down and letting go of the pull-out bar all at the same time. (It is imperative that jumper does not hang onto the pull-out bar longer than necessary for the instantaneous pull and twist. He must let go as soon as his feet leave the step.) (Figure 39)

(4) As soon as the jumper lets go of the plane, he can start counting "1-2-3" and

(5) Then pull the ripcord.

5. Smoke Jumper's Descent to Ground

After the ripcord is pulled, the parachute will open in 1.2 to 1.5 seconds. As soon as the parachute opens, the jumper should look up at the parachute and inspect it to see that no shroud lines are fouled and that the canopy is not ripped. The jumper then hooks the ripcord to the chest pack by the snap which has been placed on the cover of the chest pack for this purpose.

As soon as the jumper has done this he can look around, orient himself, and begin to maneuver the parachute as desired.

To maneuver the type of parachute used in this experiment the jumper does as follows:

(1) To turn the parachute to the right, the jumper reaches up and pulls down on the right guide line which hangs down from the right steering lobe (Figure 34). This lobe and the corresponding left lobe are located on the skirt of the parachute toward the rear of the canopy so that the lobes are always to the rear of the jumper. Pulling down on one of these lobes closes the lobe to escape of the air, forcing it out of the opposite lobe, which propels the parachute in a spiral as long as the lobe is held closed. Sometimes the chute will not turn the direction desired because of cross currents or wind peculiarities. However, the other guide line can be pulled down and the parachute will turn completely around. When the desired direction is obtained, the

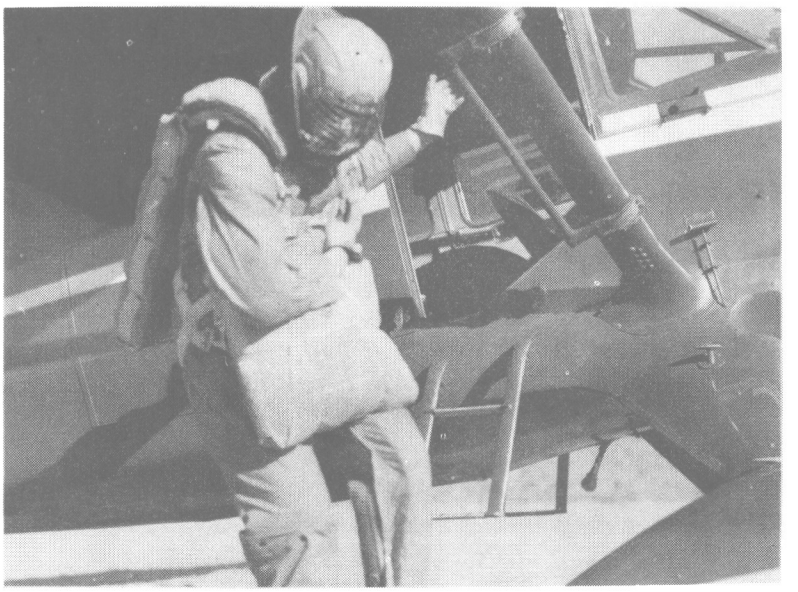


Figure 39

A jumper making a practice exit from the plane at the airport. Note the freight door is closed (Figure 38) and the main door has been removed.

guide line is released and the parachute glides of its own accord in the direction that the jumper is facing, propelled by the air escaping through the two guide lobes in the rear.

(2) To turn the chute to the left, the jumper pulls down on the left guide line.

(3) Pulling down on the two front risers causes the chute to glide forward faster; also will increase the descent rate.

(4) Pulling down on the right front riser will cause the chute to glide to the right and forward.

(5) Pulling down on the left front riser will cause the chute to glide to the left and forward.

(6) Pulling down on either of the rear risers will cause corresponding rearward glide.

(7) Pulling down lightly on both rear risers or both guide lobes will stop the forward motion of the parachute.

(8) No manipulation or maneuvering should be attempted within 100 feet of the ground.

6. Preparation for Landing

In landing in trees, it is best for the jumper to land facing the trees if possible. The parachute should be allowed to catch by itself. It should be emphatically stressed at this point that the jumper should never attempt to grab hold of limbs or tree tops, in dropping into trees, but should allow the parachute canopy and shroud lines to do the catching and supporting of the jumper's weight.

On landing in the open the jumper should attempt to land on his heels and fall forward. He may or may not pull himself up in the harness and bend his knees as the jumper wishes. A jumper should always land facing a slope.

7. Let-Down Out of Trees

On landing in a tree a jumper's body may be swung into the trunk of the tree or may be held suspended away from the tree.

If his body is close to the tree bole, he can step up on a limb to take the weight off of the harness and unbuckle the harness (Figure 40). He may just detach the riser (Figure 41) and wear the harness, so that he will have the necessary attaching ring for let-down with a rope (which is carried in the pocket of the jumper's suit) by snubbing over a limb or around the tree trunk.

Figure 40

The parachute canopy is shown billowing in the wind, having caught over the top of a 100-foot lodgepole. The jumper has released himself from the harness (shown dangling down on the right side of the tree bole) and climbed down to the ground.

Figure 41

This picture of two jumpers and the air crew assistant shows one parachute harness (on jumper at left) with a detachable riser (covered with sheepskin for protection of the jumper) and one with the regular riser strap. The let-down rope pocket is shown on the right leg of the jumper on the right.

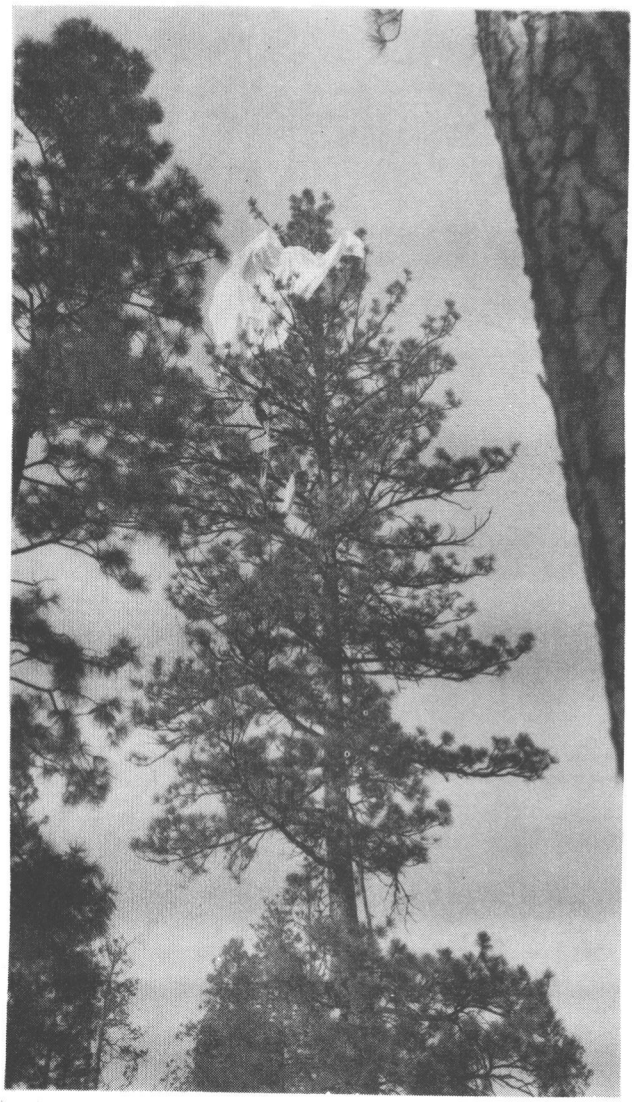


Figure 42

The timber jumper landed in this ponderosa pine and is held suspended in the branches. The emergency pack in this case took the force of the blow from the limb and was forced open by the impact. The jumper was not injured in any way and is pulling himself up on a limb to proceed to the tree trunk.

In case the jumper is held suspended away from the tree trunk, he can attach the end of his let-down rope to a harness D-ring, run it through the two riser D-rings, and snub the rope on his harness. He then pulls his weight up by the riser straps and detaches the risers from the harness. He can then let himself down to the ground by the rope or down to a lower position where he can pull or swing himself in to the tree trunk. From there on he may climb down the tree or let himself down by rope as previously described.

It must be remembered to leave the rope on the tree if needed to retrieve the parachute.

8. Retrieving the Parachute

On this experiment the retrieving of the parachute was done by two Forest Service telephone men, who used spurs and belt to get to the chutes. Otherwise their methods of retrieving the chutes will be used by the smoke chaser when returning to get the parachute after having been to the fire.

When the detachable risers are used, the loose ends of the two risers should be tied together if possible, to prevent excessive entanglement of the shroud lines.

If the parachute has caught on the side of the tree crown, limbs on which it has caught are cut off until it drops free.

When the canopy is caught over the top of the tree, the parachute must be worked off the top by cutting off the top and letting the canopy drop free outside of the crown, or worked in and bundled for dropping.

When the parachute catches over smaller trees, it may be easier to cut the tree down than to attempt to get the parachute out of the tree.

For retrieving the parachutes and for let-down out of the tree, no definite system can be described because each case will be different and will require that the jumper use his own judgment as to which will be the best and easiest method. Each man may have a method which he prefers to use. In many cases it may be desirable to drop a high climber outfit if a large tree has to be climbed to retrieve the parachute.

The value of the parachutes will make it imperative that they are not left in the weather and are not handled roughly.

9. Tools to Smoke Chaser

After the timber jumper has landed and has transmitted an OK signal to the plane, the plane will then circle at a low altitude and drop the fireman's tools to the jumper by a burlap parachute. A long yellow streamer is attached to the tools so that the jumper can easily find them in the brush and woods (Figure 15). If at all possible, the tool pack should be dropped in an opening so it will not lodge in tall trees. Extra tool packs should be available for dropping if that happens.

It is recommended that the jumpers attempt to land in spots where trees are smaller to facilitate retrieving the chute and to prevent any possibility of tools hanging up in tall trees.

PART IV - OBSERVATIONS

General analysis of all phases of the experiment brought out the following:

1. Air density and temperature seem to affect the rate of descent to such a small degree that the landing impact at 7000 feet is not noticeably harder than at 2000 feet or sea level.

2. The importance of the trial chute makes it an essential part of the procedure to determine the correct "take-off" spot for the jumper, so that he may land in the desired area.

3. It was determined that the physical and mental qualities of the jumper had a great deal to do with the fatigue factor. The caliber of men proposed to be used at the work would be forest guards and smoke chasers, who for the most part have the desired physical and mental qualities. All jumpers in connection with this project indicated that there would be much less fatigue after jumping and landing in a forest than would occur from a short hike uphill to a fire. In the case of a professional high climber who jumped, he stated that the fatigue of jumping was less than that of climbing a tree. The actual fatigue felt is caused mostly by the manipulation of the chute, which in some cases may be a good deal and in other cases almost nil. Some mental and physical fatigue is a natural reaction of the act of jumping.

4. The closer the stand of timber, the easier the landing, and trees comprise a softer landing place than the ground. Thickets of young trees and reproduction were termed "feather bed" landings by the jumpers.

5. On landing fire fighters at a fire over forest terrain, the pilot and jumpers should pick a good landing place rather than try to get too near the fire. This landing area should preferably be above the fire so that the fireman will have a down hill travel to the fire.

6. Retrieving the parachute canopy from the crown of the tree or trees is a problem which can have no definite detailed instructions. Each tree landing will be a problem in itself, but can be greatly facilitated by instructing the timber jumpers to try to land in smaller trees.

7. One thing that must be stressed is the danger from trying to grab a tree top or limb in passing down by a tree. The danger lies in the fact that the top or limb may break off after the canopy has collapsed, and the jumper might fall to

the ground before the chute can reopen. Let the chute support the jumper's weight until the canopy has enfolded the tree top or hooked over the limbs. The canopy and tentacle-like shroud lines will support a jumper's weight easily in that there are so many points of support.

8. In case the canopy should hook and then slip off, the fact that the shroud lines are still partially stretched out above the jumper's head gives the canopy a chance to open immediately with only a few feet of fall and the jumper will be landed gently on the ground. Or, if the tree is smaller, being held down from the top of the tree by the canopy and shroud lines will give the jumper only a short fall to the ground if the fall is not sufficient enough to open the canopy. The canopy also has a chance to catch again and support the jumper if it does not fall free of the limbs.

9. The ability to steer the type of parachute used in the experiment allowed a good deal of accuracy in hitting the ground target even with better than ten mile an hour ground winds. (Figures 33-34)

This type of parachute has a natural forward glide in still air of from five to eight miles per hour, and this can be used to good advantage by facing into the wind, thereby reducing the drift over the ground by a like amount.

Gusty ground winds have more effect in causing inaccuracy (Figures 35-36) than stronger steady winds, in that the unexpectedness will cause a 200 to 300 foot drift before the jumper can maneuver to compensate or he may be too close to the ground to attempt such maneuvering.

10. There was a surprisingly small number of rips and tears of the silk parachute canopies, and these were mostly only small snags or punctures. It appears that the parachute skeleton, consisting of the shroud lines, lateral bands and canopy skirt, supports the weight and protects the silk panels.

11. Of the number of landings made in forest terrain, not one jumper was injured in any way in landing, although landings were made in all types of trees, such as alpine firs, small and large lodgepoles (Figure 43), Douglas fir, Western larch, ponderosa pine, aspen, and other tall hardwoods. Steepness of the ground in no way affects tree landings. (Figure 31)

In several cases the jumpers noticed particularly that some part of the protective equipment prevented what would have been an injury.

It was evident that the chest pack was of great assistance in protection of the jumper against injury to the abdomen, chest, etc. On several landings large limbs were broken off by the weight of the swinging jumper, but the force of the blow was absorbed by the chest pack. (Figure 42)

The only injuries suffered by the jumpers were caused by the opening of the chute when still in the air. These injuries were prevented later by perfecting the jumper's clothing, equipment, and jumping technique.

12. Each professional jumper has his own ideas about "take off" from the plane. Some prefer to roll out (Jump #4 in Appendix), taking nearly a complete roll before pulling the ripcord, while others prefer to jump feet first or other ways.

As far as can be determined, there is no generally accepted and approved technique for the first part of the jump from the airplane to the time at which the ripcord is pulled. But from the jumpers' remarks, the air crew's observations, and the results of actual tries during this experiment, it was decided that the best technique to drop away from the plane was feet down, face forward, body leaning slightly back, and to drop from 20 to 70 feet below the plane before pulling the ripcord. If this position can be held, there is no discomfort during the parachute opening (Figure 44). (Jump #29)

To pull the ripcord as soon as the jumper lets go of the plane nearly always gives the jumper a hard opening shock, regardless of body position (Figure 45), due to the forward speed given by the plane. On the other hand, if the jumper pulls the ripcord after he has dropped from 20 to 70 feet below the plane, the opening shock is reduced greatly even though the jumper's body is in a bad position (Figure 46), that is, on his side or head down. If the jumper's body is in the above recommended position, the opening shock is not noticeable.

On the "roll out" method the jumper should be in a crouching position while rolling, because his body will roll too slow, fall too far before coming head-up, or have a tendency to fall head down (Figure 47) if it is held straight.

To maintain correct position while falling unless the "take-off" is perfect is almost impossible, but if the jumper is in somewhat of an upright position, facing forward, and the ripcord is pulled after a fall of 40 feet, opening shock will be negligible (Figure 48).

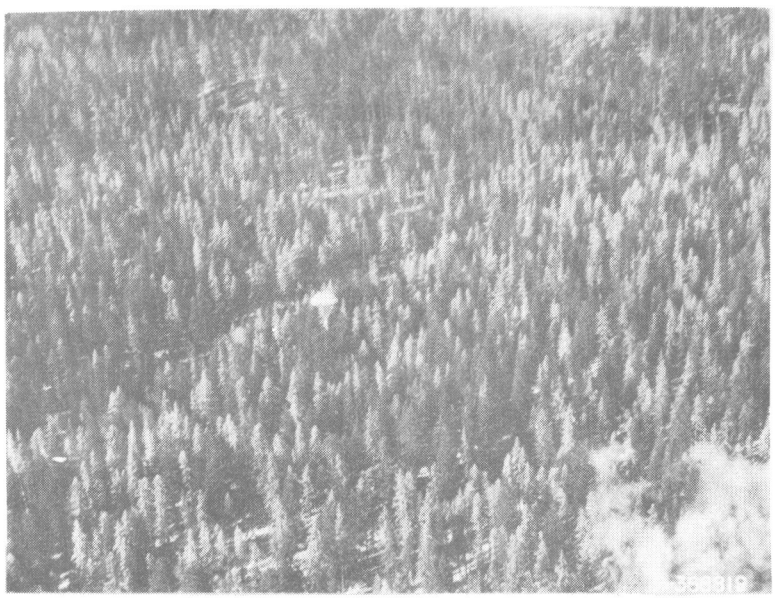


Figure 43

A timber jumper descending toward tall Douglas fir and ponderosa pine trees below. Note target fire smoke in lower right-hand corner.

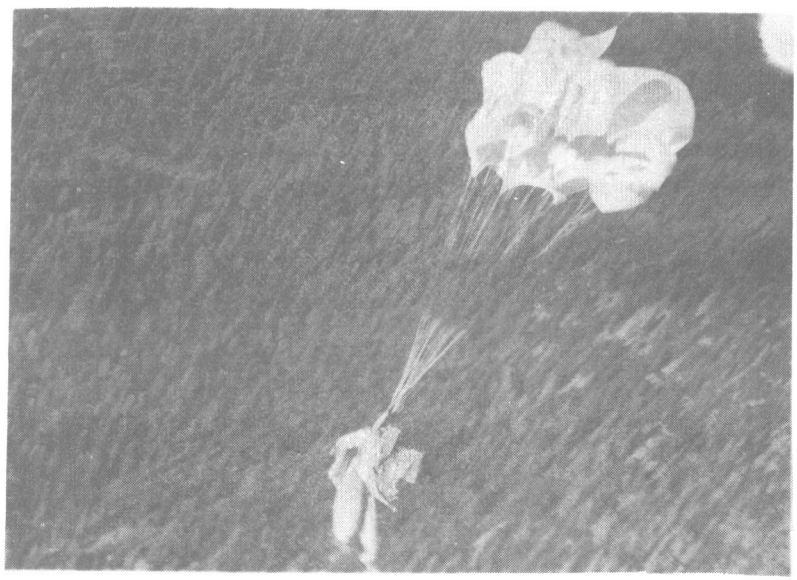


Figure 44

The jumper has dropped about 30 feet; the parachute is just starting to blossom out. Note the more vertical position of the shroud lines and the jumper's body. He should receive practically no opening shock.

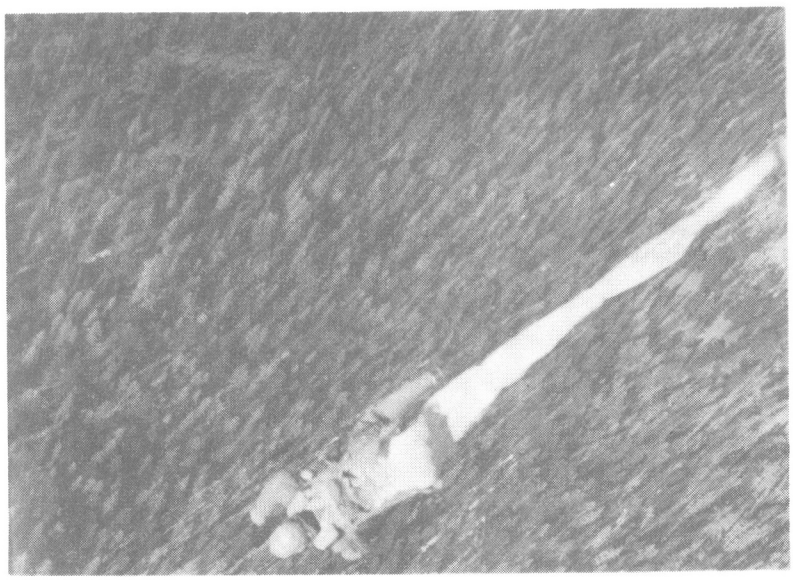


Figure 45

This jumper has pulled the ripcord when he was about ten feet below the plane. The parachute is stringing out almost horizontally. The jumper's body is tipping forward and will be due for an opening shock.

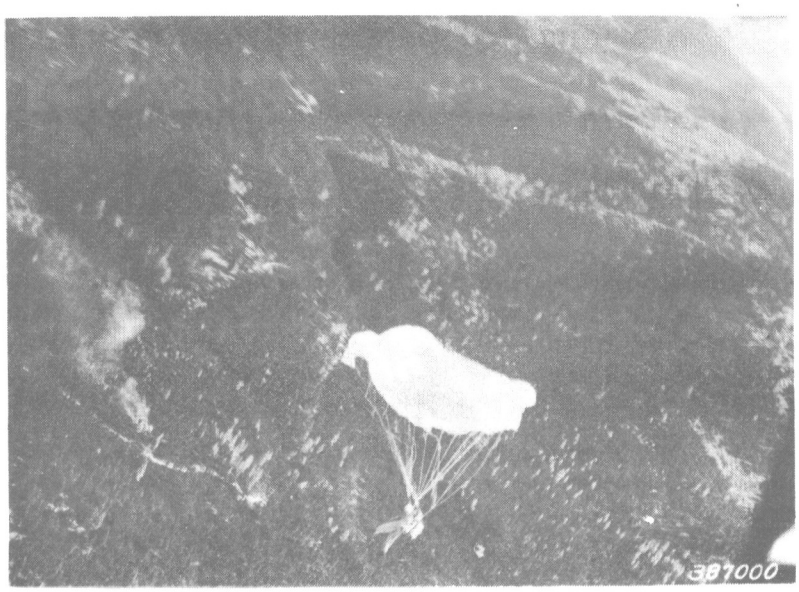


Figure 46

This jumper has dropped about 75 feet. The chute has opened up and the jumper's body which was tipped forward has been pulled back and upward by the elasticity of the shroud lines and canopy. This was an easy opening. Note the target fire and the surrounding lodgepole thickets.

Figure 47

The position of the parachute is almost identical to Figure 44, the jumper has dropped farther (over 100 feet), but his body has tipped to the right with the head slightly down. The opening will cause the jumper's body to twist, but it may not receive much of an opening shock.

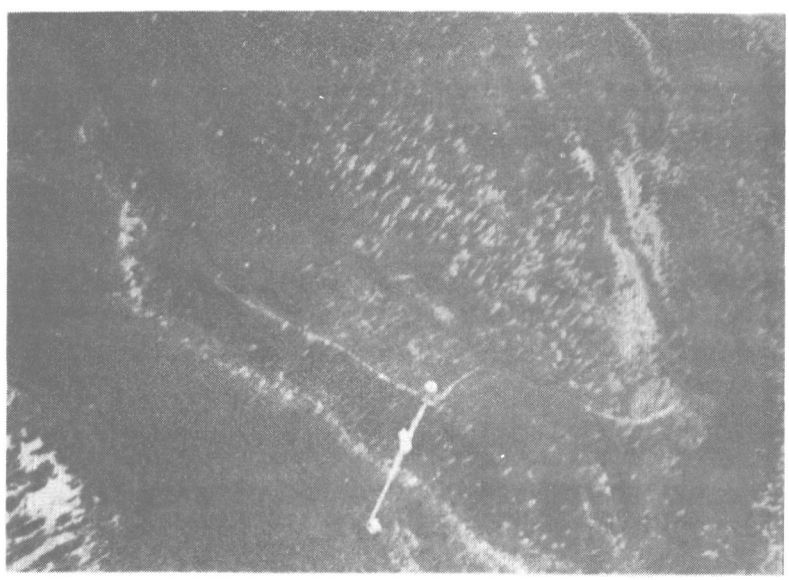


Figure 48

This jumper has dropped feet straight down, and the parachute is strung out ready to blossom out and open. He received no opening shock due to the fact that his body and the strung out parachute are in line. Note lodgepole thickets below.

It was the consensus of the jumpers that when using the Forest Service clothing, mask, ankle brace, etc., it was best to hold oneself erect and rigid with legs together, so that the majority of the load shock could be transmitted from the risers to the harness and through the leg straps and the webbing on the clothing to the strap running underneath the shoes in front of the heel.

The project personnel recommend that some provision be made to lessen the opening shock if possible. While the opening shock is not particularly disagreeable, it should be lessened.

13. Eight men made their first jumps during this experiment. With one exception, the "first timers" were yearlong Forest Service men, forest guards, or smoke chasers. All of the first timers were able to orient themselves, maneuver, and experiment with guiding the parachute. Each wanted to go back and jump from a higher altitude so they would have more time to experiment and maneuver.

Two of the smoke chasers, local boys, made a number of jumps during the experiment. They jumped into the timber on their second jumps.

Many local residents who had fire-fighting experience asked to be given a chance to jump, and it is believed that a reasonable supply of applicants for timber jumping can be procured from each local ranger district without difficulty, after witnessing a demonstration and knowing the elementary facts about parachutes and jumping.

14. A let-down technique was gradually worked out so that the jumper can let himself to the ground within a few minutes, the time depending upon the height of the tree and the tree itself. (Each type of tree will be different and will require different methods.)

15. The fireman's tools were let down to the smoke jumper by parachute from a lower altitude. A yellow streamer was attached to the bundle so that the smoke jumper could find them easily.

16. The dress-up technique was improved to such an extent that the jumper can be dressed and ready to go aloft in the airplane within ten minutes.

17. All equipment was improved during the experiment so that the equipment being used at the end of the experiment was much more appropriate and suitable for the work. Several small improvements have been thought of and will be made before being put to actual use.

18. Radio signals between the smoke jumper and the plane were not actually tried, because of the bulkiness of the present S set. A simulated radio (the size and shape of the proposed change for S set) was carried by one of the jumpers. The bulk and weight had no effect on the exit or descent of the jumper.

Radio will be the ideal system of communication because they can also be used for contact on the fire. There is a possibility that a system of cloth panels or other signals can be worked out for contact with the plane.

19. It is believed that it will be standard practice to send two jumpers down to each fire.

20. Taking in an area within a radius of 50 miles of the airport, the following schedule can be used to determine the estimated time from report to arrival of fireman in the near vicinity:

10 minutes	(warning), to warm up plane motor and dress jumpers
10 minutes	for takeoff and climb to altitude
25 minutes	to travel 50 miles
10 minutes	procedure of letting out two jumpers
55 minutes	total elapsed time from report of fire to arrival of smoke jumpers near fire

After the OK signal has been received from the jumpers, the plane can return, or if it is a large ship it can proceed to another fire or perform other missions.

21. During the early part of the experiment, considerable time was spent in preparing the jumper for the flight and also in making preparations for the jump over the target. This time was cut down to a very minimum during the last few jumps, in view of the various techniques mentioned herein developed in order to get the jumper into the air and take the jumper over the target with the least possible delay.

22. Airplane to be used in this work should be at least 5-place, and up to 12 passengers in which 8 jumpers can be carried on one flight. The planes should have a ceiling of at least 14,000 feet and be equipped with a step and exterior handhold for jumpers' takeoff.

23. Areas to be avoided by smoke jumpers are snag (old burns), abrupt rock slopes, cliffs, and such areas on which damage to the parachute and danger to the jumper would be excessive.

24. From experience gained with new jumpers on this experiment and conferences with the parachute jumper instructor, it is believed that only a short period (8-10 days) would be required to train a unit of 8 timber jumpers. (See Appendix.)

25. A few landing technique do's and don'ts should be emphasized:

(a) Don't grab limbs or tops in descending through trees.
(b) Don't attempt to maneuver the parachute within 100 feet of the ground.
(c) Attempt to land in smaller trees to facilitate let-down and retrieving of chute.
(d) Land facing the slope of a hill.
(e) Let the parachute catch and do the supporting.

26. It will be noted, in studying over the jumpers' reports, especially the first timers, the seeming lack of fear, with no panicky state of mind. This is further substantiated by the report of Captain Harry G. Armstrong, Medical Corps, U. S. Army, in a paper entitled "Objective Mental and Physical Reactions to Free Fall in Space," which is in the appendix. It is noteworthy that the project's observations of timber jumpers' mental and physical reactions in the main conform to Captain Armstrong's conclusions.

PART V - CONCLUSIONS

Terrain and Cover Types

The results of this experiment conclusively indicate that smoke jumpers can safely land in all kinds of green timber cover common to the Chelan National Forest. The major timber types are sub-alpine, lodgepole (mature and immature), mixed north slope Douglas fir and Western larch, ponderosa pine, and hardwoods (aspen and willow). Successful jumps were also made in mountain meadows, open ridges, and steep open slopes with boulders. Elevations varied from less than 2000 to 6800 feet.

It is believed that snag areas, areas of down timber, lodgepole deadenings, extremely steep slopes, deep canyons, and areas with rock cliffs or ledges should be avoided. Unknown conditions are sharp ridges with heavy winds or drafts, as they were not tested. It is believed drafts on high ridges will cause more trouble during summer months than in the fall when the tests were made. Poor visibility conditions because of fog or smoke were not tested.

Protective Clothing

The last two-piece jumper's suit developed appeared to be quite satisfactory. A few slight improvements will be made, and further tests will undoubtedly indicate additional desirable improvements. Detailed contract specifications, patterns, and tailor's cutting diagrams will need to be prepared before additional purchases are made. Auxiliary jumper's equipment was reasonably acceptable, and with further use additions and alterations can be expected.

Parachutes

The lobed 30-foot quick detachable main parachute met the required desired qualities of slow descent, maximum maneuverability, and easy release upon landing in a tree. Damage to the silk parachutes was remarkably slight. Opening shock varied from easy to severe, depending on the position of jumper and distance from the airplane at the time the parachute snapped open. Proper training and experience should tend to eliminate opening shock. Additional tests, mechanical and physical, are desirable to reduce opening shock. Detailed specifications must be made for the required parachutes when submitted to the manufacturers for bids.

Descent from Tree to Ground

The combination of a detachable parachute (riser straps) and let-down rope satisfactorily solved the problem of a jumper

descending from a tree top to the ground. Additional experience should improve the technique.

Communication

The use of ultra-high radio, panel signals, or smoke bombs offers possibilities for the jumper signaling the air crew as to his condition upon reaching the ground. Radio is preferred, since it can also be used to communicate from the fire to standby sets and lookouts. Tests should be made to determine the practicability.

Fireman or Smokechaser Equipment

Fire tools can be dropped in the conventional manner with a burlap parachute after the smoke jumper has reached the ground. An orange streamer should be tied to the unit, which should be dropped from a distance of 300 to 400 feet above the ground, similar to dropping supplies to fire camps. It is necessary that the tool unit be dropped in an opening or short trees that are easily climbed. An extra unit should be available in the airplane in case the first unit dropped lands in an unclimbable tree. In some cases it will be necessary to drop a high climber outfit so the smoke jumper can climb a large tree and recover his main parachute after the fire has been extinguished. Many details of this character will need to be worked out.

Application Tests

It is considered desirable to make a rather wide-scale application test of smoke jumping on actual fires during a fire season. Only by so doing can this experimental project be considered completed. The following items should be considered or developed during an application test:

1. Maximum ground wind permitting safe landing.
2. Effect of fog and smoke haze on airplane flights and on jumping.
3. Amount and kind of training necessary for smoke jumpers.
4. Tests on reducing opening shock.
5. Testing signalling devices, particularly ultra-high radios.
6. Determining best type of organization, dispatching and handling, repairing and storing of parachutes and jumper's equipment.
7. Best method for dropping fire tools.
8. Methods of recovering parachutes and packing out to a road.
9. Number of fires that can be covered, their location and results.
10. Compilation of costs.

Administrative Use

Region Six plans on making a comprehensive analysis, at least of its largest inaccessible area, during the early part of 1940 to determine the practical and financial aspects of using smoke jumpers as a supplemental method of transportation to small fires. Such an analysis is considered necessary to determine to what areas and under what conditions this would be a feasible method to use.

A P P E N D I X

CONTENTS

A P P E N D I X

AIRPORT EQUIPMENT

For the servicing of airplanes at airports over extended periods where no hangars or permanent facilities are available.

The items listed below will assist an operator or pilot to give flight service when wanted. The mechanical services needed for a given airplane will vary according to the age and type. The needed mechanical repairs and servicing should always be accomplished prior to each day's flight. Periodical checks of 20 and 40 hours and major repairs should be made, where repair facilities are available.

Extreme precautions must be taken, in refueling, in order to prevent water and sediment from entering the airplane fuel tank. The airplane's fuel system, as provided by the manufacturer, should be drained frequently, preferably prior to the warm-up for each day's flight. It is a known fact that moisture will gather and condense in an airplane fuel tank when left standing, unless the tanks are full. Likewise, extreme care should be taken during the refueling process. The airplane should have ground wire attached to the bottom and rear of the fuselage, making contact with airport surface when taxiing or at a standstill. If a pump is used, the hose should have some metal connection between the nozzle and the pump. See fuel servicing, below.

Project personnel, after considerable experience in operating in the field, have found that air flights can be provided when called for if the operator or pilot performs the necessary and adequate repairs and servicing in the time the aircraft is not required to be on flight.

Fuel Service

(1) Fuel: Store in 50-gallon drums.

(2) Barrel gasoline pumper with hose grounded from nozzle to pump. Ground clip and wire at nozzle to attach to metal part of airplane.

(3) Gasoline funnel with water trap. (The mouth of the funnel should project above the bottom of the funnel proper. The upper part of the neck should be provided with a water screen soldered across its diameter.)

(4) A chamois without holes or slits should be fastened over the top of the funnel and bag down into the funnel to allow a wide area through which the fuel can pass.
A ground wire and clip should be provided on the funnel, the clip fastened to the metal part of the airplane. For all fabric covered airplanes having gas tanks in the wings, an ironing board felt pad or similar materials will afford a protection to the fabric surface. When refueling, the airplane should be grounded. The airplane can be equipped with a ground wire located at the lower end and bottom of the fuselage, making a contact with the airport surface during taxiing and while on the line. If the airplane is not provided with a ground wire, then a wire soldered to an iron stake flush with the ground and provided with a battery charging clip can be attached to the metal structure of the airplane.

OIL SERVICE

(1) Lubricating oil should be furnished in either quart or 5-gallon sealed containers.

(2) Funnel should always be used in order to prevent spilling oil inside the motor cowl or in the cell.

(3) Extreme care should be taken to prevent foreign substances, dirt, etc., from entering the oil tank.

Greasing

(1) Grease gun and grease for aircraft control systems, landing gears, etc.

(2) Propeller grease (for adjustable propellers)

(3) Small oil can with light oil for certain airplane controls.

Cleaning

(1) A reasonable quantity of clean rags.

(2) Windshield solvent.

(3) Motor cleaning solvent
Aircraft motors should not be cleaned with gasoline.

(4) Buckets, washing soap and water for cleaning outside of airplane.

Field Repairing and Repainting Supply

(1) Motor tool kit

(2) Airplane tool kit

(3) Safety wire, large and small size

(4) Friction and rubber tape

(5) Small can of shellac

(6) Extra set spark plugs

(7) Spare motor and accessory parts likely to need replacements during field operation, such as valve spring, extra tubing slips, assorted motor and aircraft nuts, bolts, cotter keys,etc.

(8) Fabric repair kit (if fabric covered airplane).

Fabric dope, needles, thread, etc.

(9) Brake fluid (hydraulic brakes)

(10) Extra tube
Extra main tire tube
(Extra casing if airport surface is extremely rough. If convenient, extra casing should be among the supplies).

(11) Hydrometer for aircraft battery

(12) Parts to service radio
Extra aerial wire, insulators, tubes.

(13) Extra light bulbs, landing lights, navigation, etc., if night flying is contemplated.

(14) Flashlight.

(15) Suitable chest or box with lock, in which to store tools, small parts, and supplies for airplane.

Mooring Airplane

(1) Canvas motor cover. This should cover the motor and cowling; to be tight-fitting to keep out rain, dust, etc.

(2) Mooring stakes.

(3) Mooring ropes.

(4) Warm-up blocks, front and rear for each wheel when moored.

(5) Rope or other means to lash controls when moored.

A properly moored and blocked plane with lashed controls will withstand any windstorm.

Flight Equipment

(1) Latest section aeronautic charts (compiled and printed by U. S. Coast & Geodetic Survey).

Latest Forest Service maps.

Pamphlet ("Tabulation air navigation aids", published monthly by the Civil Aeronautic Authority, Washington, D. C.)

(2) First aid kit.

(3) Water canteen

(4) Emergency rations.

(5) Sharp hunting knife and sheath, for emergency use should, through some accident, parachute snag on airplane in flight.

Airport Equipment

(1) Tent 12' x 14', Forest Service.

(2) Fly, 14' x 20', " "

(3) Cook stove for tent, Forest Service

(4) Cooking utensils, airport guard, Forest Service

(5) Radio, fire frequency, Forest Service

(6) Radio table

(7) Bed roll, cot, airport guard

(8) Lantern for tent

(9) Yellow cotton streamers (for marking landing areas of airport and center of field)

(10) $\frac{1}{4}$" and $\frac{1}{2}$" rope

(11) 10-gallon milk can (water supply)
Canteen

(12) Transportation for air crew. Guard.

(13) Tent fly table 3' x 10', to store aircraft and other equipment.

(14) First aid kit.

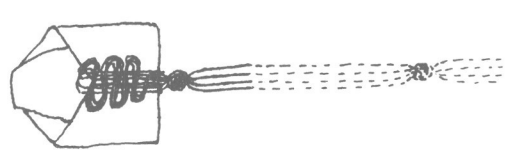
(15) Axe, shovel.

(16) Highway smudge pots or torches, in case night landings are anticipated. These torches are extremely practical on any airport, to mark ends of runway. In addition, a line of 7 or 8 of these torches can be run between end markers. Twelve torches will suffice for a runway 3000 feet long.

ROLLING THE TRIAL CHUTE

With such a light weight as used for the trial chute, a new method of rolling the burlap chute was required to speed up the opening. With the regular Region Six method of rolling the burlap chute, the weight and rolled chute would drop too far before the chute would unroll and open, so the following method of packing was used to shorten the opening time:

Follow step 1, 2, 3 and the first part of step 4 of the Region Six instructions (next page). The lines are then straightened out to lie parallel without crossing. A knot is tied in the four strands two feet from the ends. The next step is to draw the lines up and accordion them as per diagram:

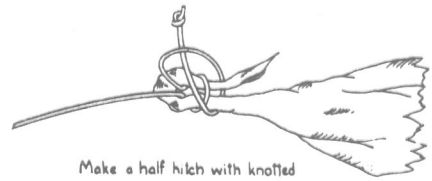


(The dotted line shows position of lines before this step was made).

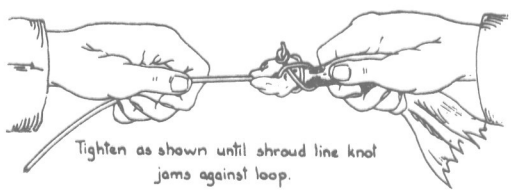
The burlap is then folded over the accordioned lines as shown in the last part of step 4. Roll from the top. The chute must be rolled tight or the lines will entangle the canopy and it will not open.

The rubber band (inner tube) is then placed around the rolled chute and over the knot (this must be done to prevent the accordioned lines from being pulled out in handling).

REGION SIX INSTRUCTIONS FOR ROLLING BURLAP CARGO CHUTE



Make a half hitch with knotted end of shroud line to lock the tie.

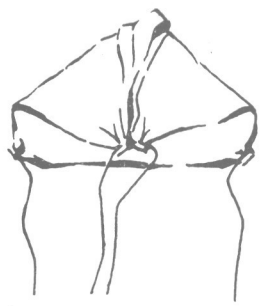


Tighten as shown until shroud line knot jams against loop.

1

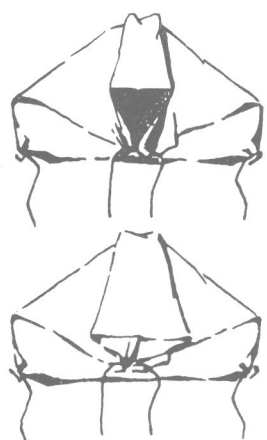
The lines are tied to the chute corners by a tight square knot, the chute being considered as another line. Then lay the chute flat on the ground with lines clear.

TYING THIMBLE:



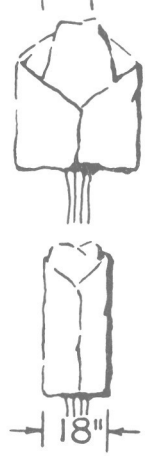
2

Two of the corners are brought together.



3

The folds are straightened and formed into a pocket to facilitate the opening of the chute.



4

The two sides are folded to the center and then folded again to the center to a width of 18 inches. If roll is less than 18" long, the chute will be too stubby, will fall too fast, and may not open.

The ends of the lines must be tied tightly to tie line of the weight bag.

This type of roll will open immediately so it must be thrown downward when dropping or it will entangle the tail assembly of the plane.

TRAINING SMOKE JUMPERS

1. Ground Work.

(a) A qualified instructor-rigger can handle about eight trainees and it is recommended that each trainee receive two days of ground work with the above instructor. This ground work would consist of (1) Familiarize himself with parachute and nomenclature; (2) Demonstration of packing and functioning of parachute; (3) Suspension in harness and practice in extricating and lowering; (4) practice tower jumping (See sketch of recommended tower); (5) Practice releasing and descending after jumping from tower, chute which is arranged for suspension a few feet off the ground; (6) Practice jump from plane on airport. (7) Instructions on use of guide lines and shroud lines for planing, turning around, hard slipping. (This should also be practiced in tower jumps).

2. Jumping.

(a) Four airport practice jumps are recommended; (b) two or three jumps in timber, or as many as are needed to satisfy the instructor that the jumper is qualified to do smoke jumping work. (c) Training in retrieving chute out of timber without unnecessary damage.

3. Communication.

Simple instructions and practice in use of ultra-high frequency radio.

4. General

Without an assistant it would take from 10 to 14 days to train a unit of 8 men, and then the instructor would have to pack chutes between suns. An assistant would speed up the training to about 8 or 10 days. He would pack chutes when not otherwise occupied.

LOFT EQUIPMENT

For Servicing 16 Men

Prepared by Frank Derry

Loft Equipment, Machines

1 Class 32 double needle Singer Sewing Machine, 1/8" gauge, with automatic bobbin winder, including stand and motor.

1 Class S. V. 7 Singer Sewing Machine, suitable for sewing parachute harness, including stand and motor. Machine to be equipped with cold waxing pot.

Loft Equipment, Hand Tools and Accessories

2 1# spools left twist 8 cord, Irish linen thread
5 4 oz. cones size E Spec. V. T. 301
20 yds. 1 in. silk tape spec. 7-13 U S A
10 yds. Silk U S A spec. 7-8-H
1 pr. large tailor scissors
1 pr. small scissors
1 pr. pliers
2 doz. needles for SV 7 sewing machine
1 doz. hand needles to take 7 cord thread
2 doz. needles for class 32 sewing machine
2 papers common pins
1 pin cushion
2 packing paddles 2" x 16" hard wood or dural.
6 shot bags $1\frac{1}{4}$" x 14 filled with BB size shot
2 line hooks
2 sets temporary packing pins
$\frac{1}{2}$ lb. beeswax
2 rip-cords (back-pack)
2 rip-cords (chest-pack)

Riggers Portable Packing Kit

1 4 oz. cone size E spec. VT 301 silk thread, natural
1 spool left twist 7 cord, Irish linen thread
4 shot bags 1½ x 12 filled with BB size shot
1 pr. pliers
1 line hook
1 set temp packing pins
1 set closing cords
1 packing paddle hardwood or dural
2 rip-cords (back-pack)
2 rip-cords (chest-pack)
1 pr. small scissors
1 carrying case

Replacement Parts for Loft

4 pack covers (backpack)
4 pack covers (chestpack)
4 pilot chutes
100 ft. 1200 lb. webbing spec. 15-11 linen webbing 1-3/4 in.
50 ft. 2800 lb. webbing spec. 15-11 soft linen webbing 2 in.
10 yds. 36 in. pack covering material mineral dyed army duck
50 ft. 3/16 in. shock-cord spec. 20-23D, hooks and eyes
1 portable packing table
6 rip-cord pockets.

SMOKE JUMPER'S SUIT AND EQUIPMENT

Shoes. 8 to 12 inch woodsman's boots with higher than ordinary heels.

Ankle braces. Made of leather to fit over the shoes, under the arch, around the ankle and lace over the instep like a shoe. Reinforced at the eyelets. The leather under the arch is so cut and sewn to fit in front of the heel of the shoe.

Back and abdominal brace. Leather front and back. (Front split and fastened with three buckles). Three elastic adjustable straps on each side. The back to fit the small of the back and the front to fit over the abdomen.

Suit: Made of: O. D. shade, 37" 13 oz. Army Duck
or 37" 10.38 oz. Vat Dye Red Army Duck.
Made in two sizes: long and short (the latter being 3 inches shorter in leg and sleeve lengths, only)

Constructed with an inner shell (Duck) to which the padding ($\frac{1}{4}$" x $\frac{1}{2}$" Western Felt, style 40)is fastened at the required points. The outer shell is placed loosely over the padding and sewn at the edges or hem of the unit.

Pants: Patterned (Patterns to be furnished later) after the Army winter flying suit. Heavy 36 inch zippers run from the top of the high waist, down the inside toward the front of each leg to the bottom of the pants. Just back of each zipper opening a 2 inch heavy webbing is sewn to the inside of the pants leg and forming a low crotch between the legs. A leather strap, riveted to the lower end of the above webbing, is run under the arch of the shoe and fastened to a buckle which is riveted to the outside of the pants leg just above the bottom hem. A 10 x 12 inch patch pocket, billowed at the edges and snaps at the top, is put on the front side of the right leg 2 inches above the bottom hem.

Jacket: Made of the same material as the pants, zippered in front and snug fitting at the waist. A half belt (soft leather) is fastened at each side and buckled in front. The jacket has an extra high, double thick, flexible collar. A 3 x 6 inch patch pocket is placed on the upper side of the right forearm. The pocket opens the full length down the middle and is closed by a zipper. A leather thong is attached to the tab of the zipper and to the blade of the knife which is carried in the pocket.

Let-down Rope: 80 feet of $\frac{1}{4}$" "Cloverleaf" manila rope.

Knife: $4\frac{1}{2}$ inch single blade pocket knife with thong attached to the pocket zipper tab.

Supporter: (Pal)

Gloves: Light weight, flexible, soft,snug fitting leather gloves. (known in the northwest as a "swamper").

Helmet: A good grade football helmet. Sizes 7 and $7\frac{1}{4}$. (Leather aviator's helmets can be worn inside if the helmet is too large for the jumper).

Mask: Made of 1/8 inch round stainless steel bars welded at 90° to each other forming a mesh ½" center to center. The measurements of the convex surface of the mask is 8 inches (length), 8½ inches (width) and a depth of 4 inches. A cushioning of doeskin covered felt shaped to cup the wearer's chin is attached to the lower inside edge of the mask. The mask is made to conform to the shape of the helmet and the individual wearer. Hinge tabs fasten the mask to the helmet at the forehead. A strap fastened on each side of the lower part of the mask hold it in place by means of a buckle secured at the rear of the ear bulges of the helmet.

FIREMAN'S TOOLS (PROPOSED) FOR TIMBER JUMPERS

1. Parachute carrying bag for parachute canopy and harness.
2. Trapper Nelson Pack Board*.
3. Pulaski tool and sheath
4. Shovel (short handle or detachable handle)
5. Backpack (rubber) and pump.
6. Flashlights
7. First Aid
8. Canteen
9. Maps, notebooks, pencils, mapcase, etc.
10. Rations

Standard one man F. F. outfit with the exception of the packboard and the additional carrying bag for the parachute canopy. *This type of packboard is much the superior for carrying the heavy bulky load (approximately 80 pounds) which the jumper will have to pack out to trail or guard station.

WEIGHTS OF COMPONENT PARTS OF SMOKE JUMPER'S EQUIPMENT

Suit - Eagle, One Piece	18 lbs.
F. S. Khaki - 2 piece	17 "
F. S. Red - 2 piece	15 "
Army Leather (2 piece) winter flying	13 "
Helmet & Mask	2 "
Back brace, ankle brace, gloves	1 "
Let-down rope	8 "
Radio S-Set (approximate)	9½ "
Parachutes, Backpack with harness	24 "
Chestpack	16 "
Boots	2 "